FINAL REPORT

HISTORIC/ARCHAEOLOGICAL MAPPING AND TESTING
PIKE HILL MINES SITE (VT-OR-27)
Corinth, Vermont

CONTRACT NO. DACW33-03-R-0002
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13. ABSTRACT *(Maximum 200 words)*

PAL, under contract with the U.S. Army Corps of Engineers, New England District, conducted historic/archaeological mapping and testing at the Pike Hill Mines Site in Corinth, Orange County Vermont. The investigations included background research and field investigations. The background research focused on collecting information needed to develop historic contexts for the project Area of Potential Effect (APE) and its environs. Background research into the mining period consisted of interviews with local mine experts and a review of local manuscript collections. The fieldwork was comprised of four primary tasks: 1) site mapping using the global positioning system (GPS) coordinates linked to the site's geographic information system (GIS) completed as part of another contract effort; 2) detailed drawings of visible aboveground structural remains related to historic period pre-/non-mining and mining activities at the site; 3) limited subsurface testing to locate and identify prehistoric and historic period resources within the preliminary APE that may be directly impacted by future site remediation project; and 4) an aerial and terrestrial color digital photographic documentation of the mine landscape. No prehistoric period resources were identified in the project APE. The field investigations did result in the identification of numerous industrial and domestic resources related to the historic mine operations during the nineteenth and early-to-mid twentieth century. The resources consist of visible structural remains and features along with a representative artifact assemblage recovered from the ground surface and in 50-x-50 centimeter test pits at select resource areas. Technical report recommendations include considering further archaeological investigations of the domestic and industrial resources in advance of any ground disturbing activities associated with future site environmental characterization work.

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EXECUTIVE SUMMARY

Introduction

The Pike Hill Mines Site is a designated National Priorities List (Superfund) site, and as such, the Environmental Protection Agency (EPA) is coordinating the hazardous material cleanup of the site to protect human health and the environment. PAL conducted the archaeological investigations for the Department of the Army, New England District, Corps of Engineers (NAE). This report presents the results of a historic/archaeological mapping and testing survey of the Pike Hill Mines Site (Vermont Archaeological Inventory VT-OR-27) in Corinth, Orange County, Vermont. The EPA's preliminary Area of Potential Effect (APE), within which cleanup activities could occur, encompasses approximately 173 acres focused on the core area of mining activity for the Union, Eureka, and Smith Mines.

Prior to the current investigations, the history of the Pike Hill Mines Site was included in an initial cultural resources study for the Elizabeth Mine in nearby South Strafford titled *Statement of Limits, National Register Eligibility, and Potential Resources in the Proposed APE, Ely Mine, South Strafford, Vermont*, prepared for Arthur D. Little, Inc. on behalf of the EPA (PAL 2000). The goal of the current investigations was to locate, identify, photograph, map, and in some cases draw visible structures, artifacts, and landscape features associated with the Pike Hill Mines Site. Limited subsurface testing was also conducted to locate and identify pre- and post-contact period resources within the preliminary APE. This project area is characterized by numerous mining-related resources for which there are surface remains, including the mine workings and entrances, ore processing sites, worker housing, and road networks.

The fieldwork, report, and database will assist the EPA in complying with Section 106 of the National Historic Preservation Act of 1966, as amended, for any future proposed undertaking at the Pike Hill Mines Site. The report is a scholarly document that not only fulfills the mandated legal requirements, but also serves as a scientific reference for future professional studies and as a framework for possible future interpretive programs. All archaeological survey work was undertaken in accordance with the Secretary of the Interior's Standards and Guidelines for Archaeology and Historic Preservation (48 FR 44716, 1983), the Advisory Council on Historic Preservation's handbook "Treatment of Archaeological Properties" (1980), and the Vermont State Historic Preservation Office's (VTSHPO) Guidelines for Conducting Archeology in Vermont (2002).

The Pike Hill Mines (Eureka, Union and Smith mines) were established in the mid-nineteenth century and operated until the early twentieth century. The site lies in the valley of Pike Hill Brook, a tributary of the Waits River, in the rugged uplands of east-central Vermont. This section of Orange County was a center of mining activity in the approximately 20-mile-long Copper Belt, and by the late nineteenth century was the location of several other mining operations, including the Elizabeth Mine in South Strafford (VT-OR-28) and Ely Mine in Vershire (VT-OR-14). Today, the Pike Hill Mines Site contains major mining landscape features, and the aboveground and buried remains of structures and features related to the post-contact period mining operations.

Survey Methodology

The current investigations of the Pike Hill Mines Site included archival research and field investigations. The archival research focused on collecting information needed to confirm and develop pre-contact and pre-/non-mining post-contact period contexts for the preliminary project APE and its environs. The research into the mining period consisted primarily of a review of previously collected Orange County copper ore mine written and cartographic documents gathered from the Bailey/Howe Library, Special Collections Department's Collamer Abbott Collection at the University of Vermont, and the Vermont Historical Society Library. The fieldwork was comprised of three primary tasks: 1) site mapping using the global positioning system (GPS) coordinates linked to the site's geographic information system (GIS) (included as Appendix E of the technical report); 2) detailed drawings of visible aboveground structural remains related to post-contact period mining and mining activities at the site; and 3) limited subsurface testing to locate and identify pre- and post-contact period resources within the preliminary APE that may be directly impacted by future site remediation. These investigations resulted in the identification of post-contact period resources for which there is physical evidence and the preparation of archaeological sensitivity maps for historic mine-related industrial and domestic archaeological resources within the site.

The goal of the archaeological survey was to locate, identify, photograph, map, and in some cases draw visible structural and landscape features and artifacts associated with the Pike Hill Mines Site. These activities were conducted in the preliminary project APE where cleanup activities would most likely take place. To accomplish this objective, three research strategies were used:

- Archival research;
- field investigations, consisting of a comprehensive site walkover/GPS survey, limited subsurface testing in the APE, and detailed drawings of select visible cultural structures and features; and
- laboratory processing and analyses of recovered cultural materials.

The archival research was conducted to assist in the development of prehistoric and pre-/non-mining historic period contexts. Historical contexts are needed to interpret and evaluate the significance of any Native American and Euro-American (non-mining) resources that may be identified during the field investigations. The research for prehistoric sites primarily consisted of a review of archaeological site files and cultural resource management reports and studies maintained at the Vermont Division for Historic Preservation (VDHP) for up-to-date information about known prehistoric sites within and/or near the site.

Additional historic research focused on examining primary and secondary documentary sources (town histories, maps, etc.), including those previously collected by PAL and others, to identify potential Euro-American (non-mining) archaeological sites within or adjacent to the project area. Interviews with persons knowledgeable about the non-mining history of the region were conducted to assist in the development of the pre-mining historic context. PAL also reviewed all previously collected documents for the Orange County copper mines as well as recent interviews and a site visit with mining historian Johnny Johnsson of Finksburg, Maryland.

The first field survey task was to produce a comprehensive site plan that depicts the spatial configuration of visible features and landscape elements. This site plan is linked to the GIS cultural resources database for the site. For the purposes of this survey, the Pike Hill Mines Site includes known and documented habitation and mining activity areas along Richardson Road and Pike Hill Brook, and to the southwest in and adjacent to the open areas associated with ore mining and processing.

Initially, a walkover survey with close ground inspection was conducted to locate and identify visible features and landscape elements across the site. The types of resources that were recorded as part of the site mapping include structural features, area features, linear features, and isolates (see Figure 2-1 of the technical report). The walkover survey was designed to maximize coverage of open and wooded areas, using pedestrian transects at 30-meter (m) intervals. The transects were oriented along predetermined compass headings within the preliminary project APE.

Visible features and landscape elements identified during the walkover survey were recorded using the Trimble GeoXT 2005 Series GPS unit. This unit was used to collect geographic and attribute data for all identified features. Prior to fieldwork, it was loaded with a custom historic resource GPS database (data dictionary) tailor made for the Pike Hill survey. When possible, the unit was set to collect data from a minimum of four satellites achieving a maximum PDOP (percent dilution of precision) of six. With these settings a minimum accuracy of 1 meter was achieved. Because of the steep terrain, these settings were unfeasible approximately 15 percent of the time. In such cases, locations were recorded based on a larger number of logged points and notes were taken for data checking once the positions were corrected and uploaded into GIS. Linear features such as roads, trenches, and stone walls were recorded as lines, while finite objects such as building corners and discrete artifact scatters were recorded as points, and larger more amorphous features such as waste rock piles were recorded as areas (polygons). Representative photographs were taken of all recorded visible features and landscape elements within the project APE.

All mapping, manipulation, and analysis of field data was performed in ESRI's ArcMap 9.2 and AutoDesk Map 3D 2007. This data was instrumental in determining where subsurface testing would occur within the project APE. Additionally, the GIS data permitted a more sophisticated analysis of the landscape and visualization of the historic spatial arrangement of the project area.

Information collected during archival research and the walkover survey was used to develop a predictive model to assess the potential for the presence of Native American and Euro-American resources, the types of sites that might be found, and their cultural and temporal affiliation. The development of predictive models for locating cultural resources has become an increasingly important aspect of CRM and planning. The predictive sensitivity model used criteria to rank the potential for the project area to contain Native American or Euro-American sites. The general criteria used to assess the Pike Hill Mine project area were proximity of known and documented cultural resources, local land use patterns, environmental characteristics, and the area's physical condition.

The pre-contact period Native American archaeological sensitivity of the Pike Hill Mines Site was specifically based on the VDHP's environmental predictive model (VTEPM) for pre-contact settlement sites, ground-truthed using information collected during the walkover survey. In the fall 2006 the VDHP predictive model was enhanced with a GIS-based mapping and information system that consists of 12 map layers derived from a GIS-based geoprocessing model. These map layers represent environmental or cultural factors conducive to pre-contact habitation and resource extraction activities. A project area is assigned anywhere from one to ten environmental/cultural factors, although the numbered of scored layers do not necessarily mean that one area is more sensitive than another. The mapping layers are used to provide preliminary, coarse information about the Native American habitability of a given area.

For the Pike Hill Mines Site, the VermontArcheoMap was used as a compliment to the VTEPM, in which individual variables are first grouped by class (River and Streams, Wetlands, etc.) and then assigned a positive or negative numerical ranking from -32 to +32. Using this score sheet, an area can be sensitized by determining the presence or absence of the specific variables, combining the associated scores, and comparing the total score to a predetermined valuation scale; a score of less than 32 is assessed as archaeologically non-sensitive while a total score of greater than 32 is considered archaeologically sensitive. The VTEPM and the ArcheoMap layers provided only a rough approximation of the preliminary project APE's archaeological sensitivity. The field walkover survey took into account the presence of microenvironmental factors that would have affected pre-contact period settlement and/or survival chances of resources based on post-contact period land uses.

The likelihood of Euro-American archaeological resources was a foregone conclusion based on the intensive mining use of the site during the post-contact period. However, based on historical maps and the comprehensive walkover survey it was possible to identify areas of intensive Euro-American utilization, areas of sporadic Euro-American use, and areas where there were little or no Euro-American resources. Furthermore, by georeferencing, or "rubber-sheeting," historical maps of the mine on top of the modern project map it was possible to ascertain which historical resources had been buried or destroyed by subsequent mining and earthmoving activities. Based on the GPS survey and archival research a number of Euro-American industrial and domestic occupation areas were identified within the current study area or APE. The majority of these historic occupation areas were grouped collectively within designated subsites, or vicinities of intensive occupation.

The archival research, including application of the VTEPM combined with the walkover survey, determined that approximately 90 acres of the 173-acre project APE possessed moderate and high sensitivity for pre-contact and post-contact (mine-related) archaeological resources. This sensitivity acreage included the 35 acres (Area 1) identified as having the highest potential for pre-contact period habitation sites. Subsurface testing was also conducted in all of the domestic subsites and along terraces overlooking small stream drainages associated with Pike Hill Brook within the preliminary project APE. Subsurface testing was also conducted in the more remote area of the Smith Mine to the south.

Ninety 50-x-50-centimeter (cm) test pits were excavated as part of the historic/archaeological survey and mapping effort. This sampling strategy is equal to approximately one test pit per sensitive acre, which is the same testing intensity applied to the Elizabeth Mine and Ely Mine historic and archaeological surveys in 2001 and 2002, conducted by PAL under NED and EPA authority. Of the 90 total test pits, 73 test pits were excavated for historic mine-related resources and 17 test pits were used for pre-contact sensitivity areas. These test pits were placed at 8-m intervals along six judgmental transects (A thru F) and as judgmentally placed test pits (JTPs 1–63).

All test pits were excavated by shovel in arbitrary 10-cm levels to sterile subsoil. Excavated soil was hand-screened through 1/4-inch hardware cloth, and all cultural materials remaining in the screen were bagged and tagged by level within each unit. The count and type of all recovered cultural material were noted. Soil profiles, including depths of soil horizons, colors, and textures, were recorded for each test pit on standard PAL test pit profile forms. All test pits were filled and the ground surface was restored to its original contour following excavation.

All cultural materials recovered from the project APE during subsurface testing and representative industrial-related artifacts collected from the entire site during the field mapping were organized by subsite and provenience, and recorded and logged in on a daily basis. Cultural materials were sorted by type and either dry brushed or cleaned with tap water depending on the material or artifact type and condition. Following the laboratory processing and cataloging activities, all recovered cultural materials were stored in acid-free Hollinger boxes with box content lists and labels printed on acid-free paper. These boxes are being temporarily stored at the PAL facilities in Pawtucket, Rhode Island according to curation guidelines established by the U.S. Army Corps of Engineers.

The current study area (including preliminary APE) contains visible structural remains and landscape features, many of which were recorded with detailed plan and cross section line drawings. Structures and features that were spatially isolated, indistinct, or better represented elsewhere on the site (e.g., a reservoir NW of the New Row domestic subsite) were not subjected to detailed measured drawings. Plan maps, which show the spatial relationship of the various features of a resource, were created in CAD and GIS so that scales of various ranges can be attained when printing, depending on the size and complexity of the resource. Cross sections were employed to depict the topographic relationships between the various features as well as aspects of wall construction.

Plans and cross sections were completed by using a Leica Total Station to survey selected physical elements at an accuracy of less than 1 inch. In general the total station was used to establish a baseline and measurements and angles were taken relative to a number of datum points. A representative foundation for both the Lower and Upper Row domestic subsites was chosen, as well as the Union Adit and the Flotation Mill for survey with the Total Station. A rough 3D model of each site was rendered using the equipment and any number of the smaller cross sections and profiles, such as mine openings, could be viewed in a CAD viewer. In general, other plan maps were created using a hand compass and tape measure to establish the angles and distances between points within a resource. Given the slope and thick vegetation on the hill, in the case of the Flotation Mill, it was necessary to establish several datum points and shoot different angles and distances from different points.

The field maps were digitized using AutoDesk Map 3D 2007 and then were exported into the GIS database. Besides adding more detail to the GIS map, the field drawings permitted the data collected during the GPS survey to be corrected for greater accuracy.

Results

No pre-contact period cultural resources were encountered during the archaeological mapping and testing at the Pike Hill Mines Site. While upland cultural adaptations have been recorded in northern New England, especially during the Late Archaic and Late Woodland periods, the focus of Native American activity in the region appears to have been concentrated in the major river valleys. With the Connecticut River only a few miles to the east, there may have been only sporadic pre-contact period settlement and land use in the vicinity of the Waits River. The rugged, upland topography would not have been particularly attractive for the types of long-term habitation activities (e.g., structures, food processing/storage/disposal pits, hearths, lithic workshops) that would have left readily discernable cultural deposits in the archaeological record at the site.

A total of 241 distinct post-contact period features were recorded during the GPS component of the fieldwork. Identified artifact, feature, and structure concentrations were collectively organized into seven major industrial subsites and miscellaneous resources. All of the identified archaeological resources were interpreted and assessed in terms of their internal complexity, physical integrity, and potential to address salient research questions. The following two tables summarize the identified cultural resources by type, time period, major visible physical remains, integrity, and historical research value (documentary data, archaeological sensitivity).

The identified post-contact period industrial and domestic-related surface and archaeological resources including structural remains and artifact assemblages at the Pike Hill Mines Site are all components of a larger, complex, integrated cultural landscape. In general, the majority of the Pike Hill Mines Site historic landscape, including remains of both industrial and domestic resources, is well preserved in the current study area. Some of these resources have undergone varying degrees of post-contact period impacts from both natural processes and human intervention. Natural processes include erosion and vegetation regrowth. Manmade processes include creation of logging and access roads, and tree and stump removal. Reworking of mill tailings east of the early-twentieth-century flotation mill to extinguish an early 1990s tailings fire has altered their original topography. No looting or other types of intentional disturbances to destroy historic and archaeological resources were noted within the current study area.

Recommendations

No pre-contact period Native American resources were identified within the project APE. The subsurface testing results conducted during the survey combined with unfavorable environmental factors and the extent of post-contact period industrial soil disturbances indicates an overall low potential for important pre-contact period resources to be present. Test pits were placed within the project APE in areas indicated as moderately sensitive by VDHP's environmental predictive model and Archeomapping tool for pre-contact settlement sites and in areas identified as having moderate Native American site potential based on the walkover survey. Archaeological testing in these areas recovered no pre-contact/contact period cultural materials. No additional archaeological investigations for Native American sites within the preliminary project APE are recommended.

It is possible that additional areas of potential effect including borrow pits and access roads may be identified in archaeologically sensitive areas outside of the current APE, in which case archaeological survey may be warranted. The survey work would be designed to identify and evaluate any potentially important belowground Native American resources.

The preliminary project APE historic mine period subsites and associated landscape features were interpreted and assessed in terms of their internal complexity, physical integrity, and potential to address priority research topics related to themes of industry and abandoned communities important to Vermont history (see VDHP 2002:22). The industrially related research themes for the identified Pike Hill Mines Site resources within the project APE focus on the various mine technologies, spatial organization of industrial complexes, and the living conditions of the mine workers. These research themes have been identified as important to Vermont history, and as such should be important to a broad public, including the community of Corinth.

Typical site environmental characterization work such as monitoring well access, machine trenching, and laydown activities would be likely to cause irrevocable changes to the landscape and important cultural features related to industrial and domestic subsites. Because of this an aerial and terrestrial color digital photographic documentation of the mine landscape was undertaken concurrently with the completion of the historic and archaeological mapping and testing fieldwork. In addition, although some of the identified landscape features may not have high archaeological interpretive potential because of integrity, they still have the potential to interpret ore processing and waste deposition on a large scale as surviving landscape features, and are therefore worthy of avoidance and preservation.

A number of the identified industrial period resources including the ore processing mill and blacksmith shop area have been assessed as having the potential to contain archaeological deposits that would contribute important new information to the historical record (Table 1). The current survey also identified domestic archaeological resource areas within the project APE that have the potential to address important priority research topics in the state of Vermont (Table 2).

Table 1. Summary of Historic Industrial Resource Areas and Subsites Identified Within the Pike Hill Mines Site.

Subsite: Location/Area (Property Owner)	Time Period	Major Visible Physical Remains	Subsurface Testing/ Cultural Materials	Integrity[1]	Historical Research Value: Documentary Data[2]	Historical Research Value: Archaeological Sensitivity	Historical Research Value: Interpretive Potential
Union Mine (John & Nancy L. Ayers)	ca. 1854 – ca. 1882	see below for each subarea of the subsite					
Shaft/Adit Area	ca. 1854 – ca. 1882	Mine shaft, adit, hoist house foundation and machinery pads, 2 open cuts, 1 prospect trench, water collection features, and six stone bldg. foundations	None	Good	Poor to fair	Moderate	Underground mining; ore haulage; hoisting activity and associated equipment
Upper Cobbing House Area	ca. 1854 – ca. 1882	Stone foundations, stone walls, masonry dam, vegetated and unvegetated waste rock piles	None	Fair to Good	Poor to fair	Moderate	Ore processing; mining activity and impact on landscape
Waste Rock/ Walls/Foundations Area	ca. 1854 – ca. 1882	Stone foundations, stone walls, vegetated and unvegetated waste rock piles, ore processing machinery parts	None	Poor to Fair	Poor to fair	Moderate	Ore processing and associated equipment; mining activity and impact on landscape
Lower Cobbing House Area	ca. 1879 – ca. 1882	Stone foundations, stone walls, waste rock piles, earth ramp, haulage roads	None	Poor to Fair	Poor to fair	Moderate	Ore processing; mining activity and impact on landscape
Eureka Mine (John & Nancy L. Ayers)	ca. 1854 – ca. 1919	see below for each subarea of the subsite					
Cuprum Cut/Shaft Area	ca. 1854 – ca. 1919	Open cut, exploration pits, one shaft, stone foundation and platform, waste rock piles, mine roads	None	Good	Poor to fair	Moderate to High	Underground mining; ore haulage; hoisting activity and associated equipment; mining activity and impact on landscape

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Subsite: Location/Area (Property Owner)	Time Period	Major Visible Physical Remains	Subsurface Testing/ Cultural Materials	Integrity[1]	Historical Research Value: Documentary Data[2]	Historical Research Value: Archaeological Sensitivity	Historical Research Value: Interpretive Potential
Eureka Shaft/Upper Adit Area	ca. 1863 – ca. 1919	Two open cuts, one adit, one shaft, two stone foundations, earth and stone ramp, mine roads, and waste rock piles	None	Fair to Good	Poor to fair	Moderate to High	Underground mining; ore haulage; hoisting activity and associated equipment; mining activity and impact on landscape
Eureka Lower Adit/Blacksmith Shop Area	ca. 1863 – ca. 1919	Adit, stone walls, stone foundations (including blacksmith shop), blacksmith forge and associated features, ore carts, waste rock piles, and mine roads	None	Good to Excellent	Poor to fair	High	Mine support/service activities; mining activity and impact on landscape; underground mining; ore haulage
Eureka Ore Mill	ca. 1905 – ca. 1919	Stone foundations – ore mill and reservoirs, mine roads, waste rock piles, and differentiated mill tailings	None	Good to Excellent	Moderate	High	Mining activity and impact on landscape; ore beneficiation; associated power generation; and associated process and equipment
Prospect Trenches (Ayers; Gary D. Bahlkow)	ca. 1846? ca. 1907–ca. 1913?	Various prospect trenches	1 test pit; no cultural materials	Good	Poor to fair	Low	Mining activity and impact on landscape
Smtih Mine (Gary D. Bahlkow)	Ca. 1846 Ca. 1907-1913	Shaft, adit, stone well, stone foundations, waste rock piles, mine road	7 test pits – yielded a low density of cultural materials	Poor to fair	Poor to fair	Low	Mining activity and impact on landscape

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Subsite: Location/Area (Property Owner)	Time Period	Major Visible Physical Remains	Subsurface Testing/ Cultural Materials	Integrity[1]	Historical Research Value: Documentary Data[2]	Historical Research Value: Archaeological Sensitivity	Historical Research Value: Interpretive Potential
Exploration Adit/Prospect Pits/Waste Rock Pile 39 Area (John & Nancy L. Ayers)	Ca. 1845 to ca. 1919?	Exploration pits, adit, waste rock pile, drainage channel	None	Fair	Poor to fair	Low	Mining activity and impact on landscape
Granite Quarry/Cutting Area (John & Nancy L. Ayers)	Early-mid 19th c.? Mine-related?	Quarried and cut granite materials, quarry pit	None	Good	Poor to fair	Low	Non-mine and/or mining activity and impact on landscape
Foundation 24 Area (John & Nancy L. Ayers)	Ca. 1880-1919	Stone foundation (reservoir)	None	Good	Poor to fair	Low	Mine support/service activities
Wall 6 and Wall 26 (John & Nancy L. Ayers)	Early-mid 19th c.?	Stone walls	None	Good	Poor to fair	Low	Non-mine and/or mining activity and impact on landscape
Exploration Pits 5, 6, 7 (John & Nancy L. Ayers)	Ca. 1845 to ca. 1880	Exploration pits	None	Good	Poor to fair	Low	Non-mine and/or mining activity and impact on landscape

[1] based on visual inspection only; does not include potential belowground resources

[2] based on known and expected available primary and secondary sources: company records, geological reports, anecdotal/travelers' accounts, historic maps and photographs,etc.

Table 2. Summary of Historic Domestic Mine-Related Resource Areas and Subsites Identified Within the Pike Hill Mines Site.

Location/Area (Property Owner)	Estimated Date of Occupation	Major Visible Physical Remains	Subsurface Testing/Cultural Materials	Integrity[1]	Historical Research Value		
					Documentary Data[2]	Archaeological Sensitivity	Priority Research Topics
Upper Row (John & Nancy L. Ayers)	ca. 1863-ca. 1919	6 stone foundations, 1 well, 1 privy; domestic trash dump	24 test pits – yielded a high density of mid-19th through mid-20th c. domestic and construction debris	Fair to Good	Poor to fair	High	Community infrastructure; health/sanitation/diet
Lower Row (John & Nancy L. Ayers)	ca. 1863-ca. 1919	10 stone foundations; 3 privies; 1 well; 1 stonewall	22 test pits - yielded moderate density of mid-to late 19th c. domestic and construction debris	Good to Excellent	Poor to fair	High	Community infrastructure; health/sanitation/diet
New Row (John & Nancy L. Ayers)	ca. 1878-1882 (possibly later)	1 long dormitory stone foundation, comprised of 11 units; 1 privy	15 test pits - yielded low density of mid-late 19th c. domestic and construction debris	Good to Excellent	Poor to fair	High	Community infrastructure; health/sanitation/diet
General Store (John & Nancy L. Ayers)	ca. 1863-ca. 1919	None	None	Possibly destroyed	Poor to fair	Low to moderate	Community infrastructure; health/sanitation/diet
School House (unknown)	ca. 1863-ca. 1919	Unknown location	None	Unknown	Poor to fair	Unknown	Community infrastructure
Union Mine Office	ca. 1863-ca. 1919	Stone foundation and wood floorboards, timbers	3 test pits – yielded a moderate density of mostly construction materials, also schist drill core fragments	Good to excellent	Poor to fair	High	Mine and village support/service activities
Eureka Mine Office	ca. 1863-ca. 1919	Partially filled cellar hole, some stonework	3 test pits – yielded a low density of construction materials, one whiteware sherd	Poor to fair	Poor to fair	Moderate	Mine and village support/service activities

[1] based on visual inspection conducted to date and/or limited subsurface testing

[2] based on known and expected available sources: land evidence and probate records, tax records, etc.; company records, anecdotal/travelers' accounts, historic maps and photographs, etc.

Any ground disturbing activities associated with site environmental characterization work should take place with consideration for further investigation of the domestic and industrial archaeological resources, with the exception of the Prospect Trenches and Isolates subsites assigned low archaeological potential and research value. A collaborative effort between cultural resource specialists and a project geotechnical team would be expected to provide some of the information identified as data gaps in the research priority topics discussed above. Pending the evaluation of archaeological data collected during potential site characterization work, additional systematic archaeological investigations of targeted resources could be warranted as part of mitigation efforts for a cleanup project. Domestic archaeological resource areas having high research potential should be avoided during site environmental characterization work and cleanup activities.

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CHAPTER ONE

INTRODUCTION

Scope and Authority

Scope

This report presents the results of the Phase IA historical and archaeological investigation of the Pike Hill Mines Site (Vermont Archaeological Inventory VT-OR-27) in Corinth, Orange County, Vermont (Figure 1-1). The Pike Hill Mines Site is a designated National Priorities List (Superfund) site, and as such, the Environmental Protection Agency (EPA) is coordinating the hazardous material cleanup of the site to protect human health and the environment. The EPA's preliminary Area of Potential Effect (APE), within which cleanup activities could occur, encompasses approximately 173 acres focused on the core area of mining activity for the Union, Eureka, and Smith Mines. The historical and archaeological investigations were conducted within this preliminary project APE. The investigations were conducted in support of the proposed EPA Superfund cleanup project at the Pike Hill Mines Site. PAL conducted the historical and archaeological investigations for the Department of the Army, New England District, Corps of Engineers (NAE).

Prior to the current investigations, the history of the Pike Hill Mines Site was included in an initial cultural resources study for the Elizabeth Mine in nearby South Strafford titled *Historical Context and Preliminary Resource Evaluation of the Elizabeth Mine, South Strafford, Vermont*, prepared for Arthur D. Little, Inc. on behalf of the EPA (PAL 2001). The goal of the current investigations was to locate, identify, photograph, map, and in some cases draw visible structures, artifacts, and landscape features associated with the Pike Hill Mines Site. Limited subsurface testing was also conducted to locate and identify pre- and post-contact period resources within the preliminary APE. This project area is characterized by numerous mining-related resources for which there are surface remains, including the mine entrances, ore processing sites, worker housing village, and road networks.

The fieldwork, report, and database will assist the EPA in complying with Section 106 of the National Historic Preservation Act of 1966, as amended, for any future proposed undertaking at the Pike Hill Mines Site. The report is a scholarly document that not only fulfills the mandated legal requirements, but also serves as a scientific reference for future professional studies and as a framework for possible future interpretive programs.

Authority

The archaeological investigations were conducted under the authority of the National Historic Preservation Act of 1966, as amended (16 U.S.C. 470 et seq.); the Comprehensive Environmental Response Compensation, and Liability Act (CERCLA–U.S. Code–Title 42); the Advisory Council on Historic Preservation, Protection of Historic Properties (36 CFR 800); and the National Register of Historic Places, Nominations by States and Federal Agencies (36 CFR Part 60).

Figure 1-1. Map of Vermont, showing the location of the Pike Hill Mines Site in Orange County.

All archaeological survey work was undertaken in accordance with the Secretary of the Interior's Standards and Guidelines for Archaeology and Historic Preservation (48 FR 44716, 1983), the Advisory Council on Historic Preservation's handbook "Treatment of Archaeological Properties," and the Vermont State Historic Preservation Office's (VTSHPO) *Guidelines for Conducting Archeology in Vermont* (2002).

Site Description

The Pike Hill Mines (Union, Eureka, and Smith mines) were established in the mid-nineteenth century and operated until the early twentieth century. The site lies in the valley of Pike Hill Brook, a tributary of the Waits River, in the rugged uplands of east-central Vermont (Figure 1-2). This section of Orange County was a center of mining activity in the approximately 20-mile-long Copper Belt, and by the late nineteenth century was the location of several other mining operations, including the Elizabeth Mine in South Strafford (VT-OR-28) and the Ely Mine in the town of Vershire (VT-OR-14). Today, the Pike Hill Mines Site contains major mining landscape features, and the aboveground and buried remains of structures and features related to the post-contact period mining operations.

Nature of Study

The current investigations of the Pike Hill Mines Site included archival research and field investigations. The archival research focused on collecting information needed to develop pre-contact and pre-/non-mining post-contact period contexts for the APE and its environs. Additional research into the mining period focused on the Pike Hill Mines site and the evolution of ore mining and beneficiation technology. This research included interviews with regional mine historians and a review of regional manuscript collections. The fieldwork was comprised of three primary tasks: 1) site mapping using global positioning system (GPS) coordinates linked to the site's geographic information system (GIS) completed as part of another contract effort; 2) detailed drawings of visible aboveground structural remains related to post-contact period non-mining and mining activities at the site; and 3) limited subsurface testing to locate and identify pre- and post-contact period resources within the preliminary APE that could be directly impacted by EPA-sponsored cleanup activities. The subsurface testing included several locations considered to be sensitive for pre-contact period Native American resources. These field investigations resulted in the identification of post-contact period resources for which there is physical evidence, and the preparation of archaeological sensitivity maps for pre- and post-contact archaeological resources within the approximately 173-acre project APE study area.

Personnel

Archival research and field investigations for the Pike Hill Mines Site were conducted from September 2006 to June 2007. PAL staff involved in the project include Deborah C. Cox (project manager), Suzanne G. Cherau (principal investigator), Matthew A. Kierstead (industrial historian), Tim Wallace (project archaeologist), and Mark Lance, John Daly, Nick Leden and Billie Seet (archaeological assistants). Matthew A. Kierstead assisted with the field mapping and photography. Tim Wallace, assisted by Mark Lance and Nick Leden, collected the GPS data. Erin Kuns (laboratory supervisor) and Loren Sparling (laboratory analyst) were responsible for the processing and cataloging of all cultural materials.

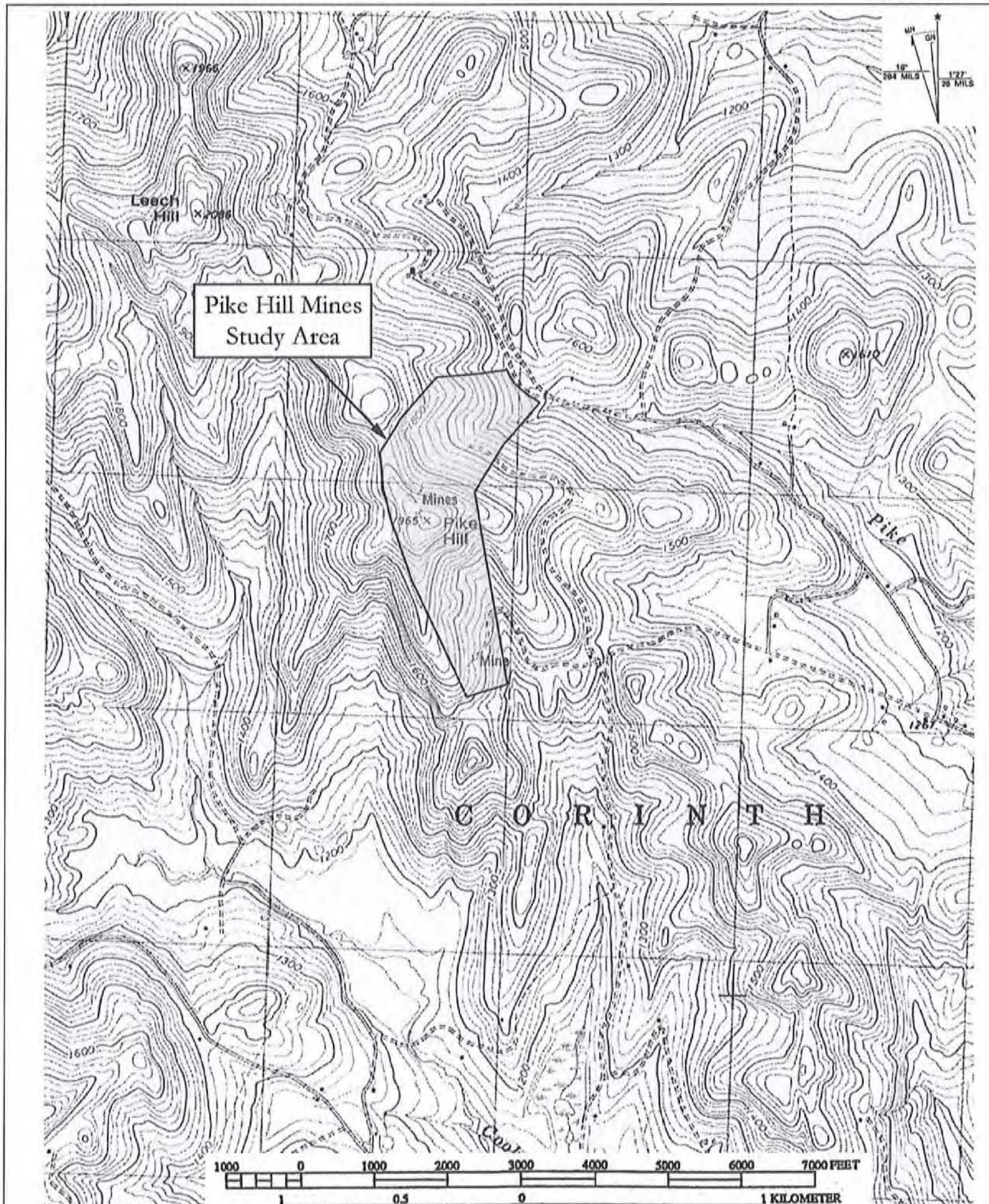

Figure 1-2. Location of the Pike Hill Mines Site on the West Topsham, Vermont USGS topographic quadrangle, 7.5 minute series.

Pike Hill Mines Historic and Archaeological Survey May 2010

Acknowledgements

The authors would like to acknowledge the assistance of mining historians Collamer M. Abbott of White River Junction, Vermont, and Johnny Johnsson of Finksburg, Maryland; and the staffs of the University of Vermont Bailey-Howe Library Special Collections Department, Burlington, Vermont (especially Jeffrey Marshall); the Vermont State Library and Vermont State Archives, Montpelier, Vermont; and Vermont Historical Society Library, Barre, Vermont.

Disposition of Project Materials

All project information (i.e., field recording forms, maps, cultural materials, and photographs) is currently on file at PAL, 210 Lonsdale Avenue, Pawtucket, Rhode Island. PAL serves as a *temporary* repository for recovered cultural materials. The permanent curation of this artifact collection will be the subject of consultation between the EPA, VTSHPO, and the individual property owners.

CHAPTER TWO

METHODOLOGY

The goal of the historic and archaeological survey was to locate, identify, photograph, map, and in some cases draw visible structural and landscape features and artifacts associated with the Pike Hill Mines Site. These activities were conducted in the approximately 173-acre study area, which encompasses the preliminary project APE where EPA-sponsored cleanup activities could occur and surrounding lands. To accomplish this objective, three research strategies were used:

- archival research and interviews;

- field investigations, consisting of a comprehensive site walkover/GPS survey, limited subsurface testing in the preliminary APE, and detailed drawings of select cultural features; and

- laboratory processing and analyses of recovered cultural materials.

This report section describes the methods used during each of the archival research and field activities. The results of the research and field investigations are discussed and evaluated in Chapters 7 and 8.

Archaeological Significance and Historic Contexts

The different phases of archaeological investigation (survey, site evaluation, and data recovery) reflect preservation planning standards for the identification, evaluation, registration, and treatment of cultural resources (National Park Service [NPS] 1983). This planning structure is based on the eligibility of cultural resources for listing in the National Register of Historic Places. The National Register is the official federal list of properties that have been evaluated and found significant according to certain criteria. The results of a field survey and site evaluation are used to make recommendations about the significance and eligibility of any resource.

The standards for determining the significance of cultural resources, a task required of federal agencies, are found in the guidelines provided by the NPS (36 CFR 60): the National Register Criteria for Evaluation. The following four criteria are given for determining if “the quality of significance in American history, architecture, archaeology, engineering, and culture is present in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, materials, workmanship, feeling and association” (36 CFR 60):

A. that are associated with events that have made a significant contribution to the broad patterns of our history; or

B. that are associated with the lives of persons significant in our past; or

C. that embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or

D. that have yielded, or may be likely to yield, information important to prehistory or history.

Most archaeological sites listed in the National Register of Historic Places have been determined eligible under criterion A and/or D. For eligibility under these criteria, a number of issues must be addressed, including the kind of data contained in the site, the relative importance of research topics suggested by the data, whether these data are unique or redundant, and the current state of knowledge relating to the research topic(s) (McManamon 1990:14–15; VDHP 2002). A defensible argument must establish that a site "has important legitimate associations and/or information value based upon existing knowledge and interpretations that have been made, evaluated, and accepted" (McManamon 1990:15).

The criteria used to evaluate the significance of cultural resources are applied in relation to the historical contexts of the resources. A historical context is defined as follows:

> At minimum, a historical context is a body of information about past events and historic processes organized by theme, place, and time. In a broader sense, a historical context is a unit of organized information about our prehistory and history according to the stages of development occurring at various times and places (NPS 1985).

Historical contexts provide an organizational format that groups information about related historical properties based on a theme, geographic limits, and chronological periods. A historical context may be developed for Native American, historic, and/or modern cultural resources. Each historical context is related to the developmental history of an area, region, or theme (e.g., agriculture, transportation, waterpower), and identifies the significant patterns that particular resource can represent.

Historical contexts are developed by:

- identifying the concept, time period, and geographic limits for the context;
- collecting and assessing existing information about these limits;
- identifying locational patterns and current conditions of the associated property types;
- synthesizing the information in a written narrative; and
- identifying information needs.

"Property types" are groupings of individual sites or properties based on common physical and associative characteristics. They serve to link the concepts presented in the historical contexts with properties illustrating those ideas (NPS 1983:44719).

A summary of an area's history can be developed by a set of historical contexts. This formulation of contexts is a logical first step in the design of any archaeological survey. It is also crucial to the evaluation of individual properties in the absence of a comprehensive survey of a region (NPS 1983:9). The result is an approach that structures information collection and analyses. This approach further ties work tasks to the types and levels of information required to identify and evaluate potentially important cultural resources.

The following research contexts have been developed to organize the data relating to the Native American and Euro-American cultural resources identified within the Pike Hill Mines Site:

- Native American land use and settlement in east-central Vermont (including the Waits River drainage), circa (ca.) 12,500 to 300 years before present (B.P.); and

- Historic land use and settlement patterns of Corinth, Vermont, ca. A.D. 1650 to present; and

- The mining history of the Pike Hill Mines Site, ca. 1846 to 1919.

- Post-mining use and alterations of the landscape and features, including World War II era waste-rock mining.

Historical contexts, along with expected property types and locational patterns, are discussed in detail in Chapters 4 and 5. The potential research value of the known and expected pre-contact period, pre-/non-industrial, and post-contact period industrial resources identified within the Pike Hill Mines Site is evaluated in terms of these historical contexts. This evaluation, along with management recommendations, is presented in Chapter 9.

Archival Research

Archival research was conducted to assist in the development of pre-contact and pre-/non-mining post-contact period contexts. Historical contexts are needed to interpret and evaluate the significance of any Native American and Euro-American (non-mining) resources that may be identified during the field investigations. The research for pre-contact sites primarily consisted of a review of archaeological site files and recent cultural resource management reports and studies maintained at the Vermont Division for Historic Preservation (VDHP) for up-to-date information about known pre-contact sites within and/or near the project site.

Additional historical research focused on examining primary and secondary documentary sources (town histories, maps, etc.), including those previously collected by PAL and others, to identify potential Euro-American (non-mining) archaeological sites within or adjacent to the project area. An interview with mining historian Collamer Abbott regarding the industrial use of the site was also conducted, along with a review of his archival collections at the University of Vermont and the Vermont Historical Society for preliminary information relating to its contents and potential contribution to the site's mining period history. Interviews and a site visit with mining historian Johnny Johnsson, Vermont mine historian, presently of Finksburg, MD, were also conducted.

Walkover/Site Mapping

The first survey task was to produce a comprehensive site plan that depicts the spatial configuration of visible features and landscape elements. This site plan is linked to the GIS cultural resources database for the site. For the purposes of this survey, the Pike Hill Mines Site includes known and documented habitation and mining activity areas along Richardson Road and Pike Hill Brook, and to the southwest along and adjacent to the open areas associated with ore mining and processing.

Initially, a walkover survey with close ground inspection was conducted to locate and identify visible features and landscape elements across the site. The types of resources that were recorded as part of the site mapping include structural features, area features, linear features, and isolates (Table 2-1). The walkover survey was designed to maximize coverage of open and wooded areas, using pedestrian transects at 30-meter (m) intervals. The transects were oriented along predetermined compass headings within the project APE (Figure 2-1).

Table 2-1. Visible Features and Landscape Elements Included in GPS Site Mapping, Pike Hill Mines Site.

Feature	Examples
Structural Features	Collapsed structures Building foundations Machinery footings Cellar holes Privies Wells Cisterns Reservoirs
Area Features	Prospect Pits Waste piles (e.g., ore, development rock, trash dump) Quarry
Linear Features	Open Cuts Ramps Trenches Stone walls Stone dams Roads, tram routes, (historic) foottrails
Point Features	Prospect pits Shafts, adit entrances Small-scale features Large-scale artifacts

Visible features and landscape elements identified during the walkover survey were recorded using the Trimble GeoXT 2005 Series GPS unit. This unit was used to collect geographic and attribute data for all identified features. Prior to fieldwork, it was loaded with a custom historic resource GPS database (data dictionary) tailor made for the Pike Hill survey. When possible, the unit was set to collect data from a minimum of four satellites achieving a maximum PDOP (percent dilution of precision) of six. With these settings a minimum accuracy of 1 meter was achieved. Because of the steep terrain, these settings were unfeasible approximately 15 percent of the time. In such cases, locations were recorded based on a larger number of logged points and notes were taken for data checking once the positions were corrected and uploaded into GIS. Linear features such as roads, trenches, and stone walls were recorded as lines, while finite objects such as building corners and discrete artifact scatters were recorded as points, and larger more amorphous features such as waste rock piles were recorded as areas (polygons). Representative photographs were taken of all recorded visible features and landscape elements within the project APE.

All data collected during the walkover was transferred from the GPS unit to the project database using Trimble's Pathfinder Office 3.1. The positions were differentially corrected in Pathfinder Office and exported as Environmental Systems Research Institute, Inc. (ESRI) shape files. All mapping, manipulation, and analysis of field data was performed in ESRI's ArcMap 9.2 and AutoDesk Map 3D 2007. Since similar atmospheric disturbances can be assumed in areas that are not far from each other, GPS data is easily optimized through differential correction by comparing collected field data to data from a regional base station.

Archaeological Sensitivity Assessment

Information collected during archival research and the walkover survey was used to develop a predictive model to assess the potential for the presence of Native American and Euro-American resources, the types of sites that might be found, and their cultural and temporal affiliation. The development of predictive models for locating cultural resources has become an increasingly important aspect of CRM and planning.

The predictive sensitivity model used criteria to rank the potential for the project area to contain Native American or Euro-American sites. The general criteria used to assess the Pike Hill Mine project area were proximity of known and documented cultural resources, local land use patterns, environmental characteristics, and the area's physical condition.

Native American Sensitivity Criteria

Sets of key environmental variables used to predict the location of Native American sites have been compiled from research conducted by professional archaeologists. These studies have demonstrated that certain environmental and topographical settings are strongly associated with the presence of Native American sites. The most productive studies have been of large areas with a variety of environmental settings that were field tested to determine the validity of the predictive model. For example, analysis of several hundred sites in southeastern New England (Thorbahn et al. 1980) found that the highest density and greatest clustering of pre-contact sites occurred within 300 m of low-ranking streams and large wetlands. Other studies have found that site locations are strongly associated with modern wetland densities (Mulholland 1984). Wetlands provide both a home and breeding habitat for a diverse set of animals, support foods, and other vegetation. Pre-contact Native Americans sought the most productive wetlands, including those with a wide variety of resources and those with consistent and reliable resource availability (Hasenstab 1991; Nicholas 1991; Thorbahn 1982; Thorbahn et al. 1980).

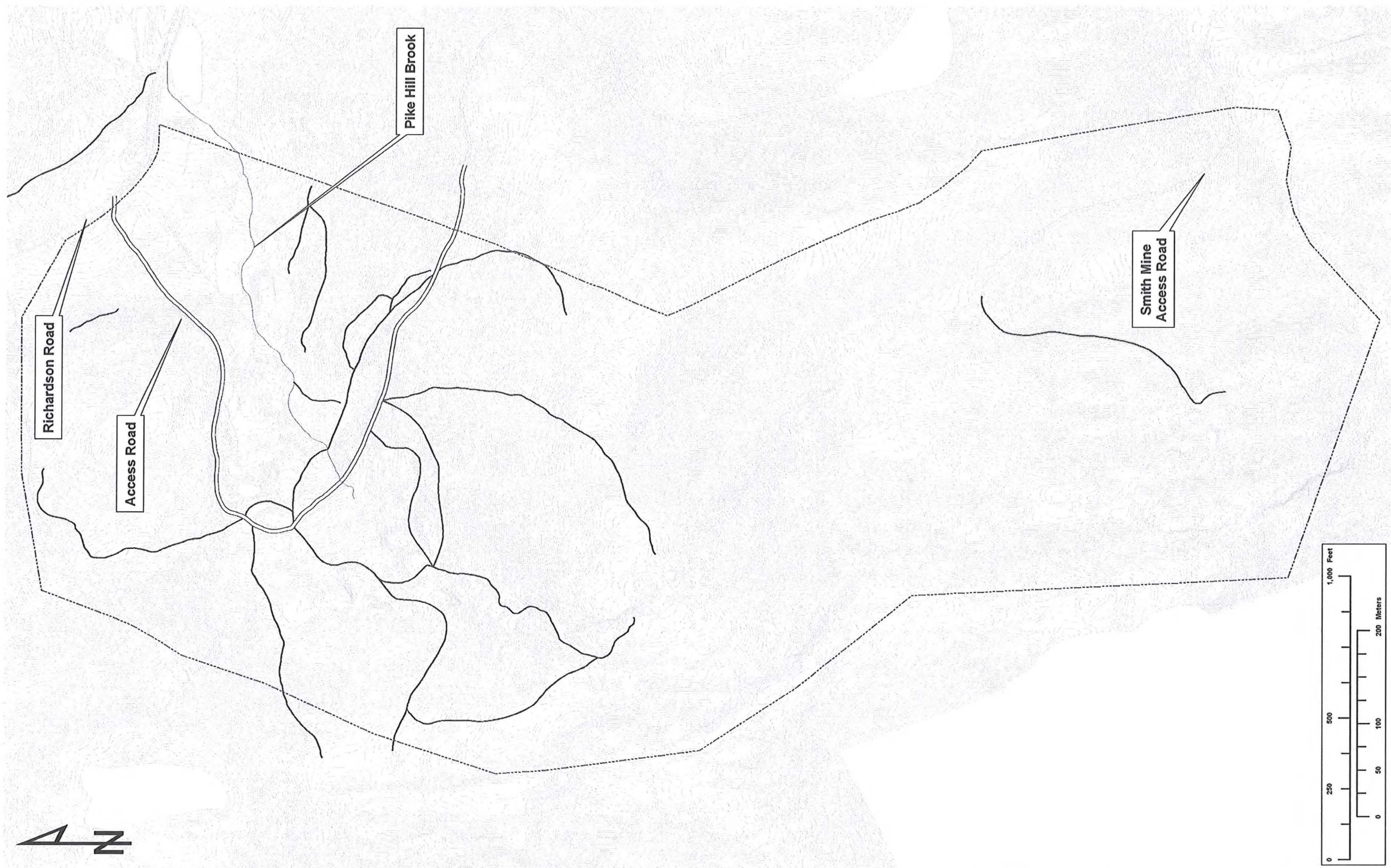

Figure 2-1. Map of Pike Hill Mines Study Area, showing areas subjected to GPS survey and mapping.

Geologic data provides information about lithic resources and about current and past environmental settings and climates. Bedrock geology helps to identify where raw materials for stone tools were obtained by pre-contact groups and gives indications of how far from their origin lithic materials may have been transported or traded. The variety and amount of available natural resources are dependent on soil composition and drainage, which also play a significant role in determining wildlife habitats, and forest and plant communities. Geomorphology assists in reconstructing the paleoenvironment of an area and is particularly useful for early Holocene (PaleoIndian and Early Archaic period) sites in areas that are different physically from 10,000 years ago (Simon 1991). Recent landscape changes such as drainage impoundments for highways and railroads, the creation of artificial wetlands to replace wetlands impacted by construction, or wetlands drained for agricultural use, can make it difficult to assess an area's original configuration and current archaeological potential (Hasenstab 1991:57). This is particularly true at Pike Hill Mine where the courses of waterways have been manipulated and the imposition of waste rock and tailings on the landscape may have affected the natural freshwater drainage patterns.

Beyond predicting where sites are located, archaeologists attempt to associate cultural and temporal groups with changes in the environmental settings of sites. Changes in the way pre-contact groups used the landscape can be investigated through formal multivariates such as site location, intensity of land use, and specificity of land use (Nicholas 1991:76). However, distinguishing the difference between repeated short-term, roughly contemporaneous occupations and long-term settlements is difficult and can make interpreting land use patterns and their evolution problematic (Nicholas 1991:86).

Vermont Native American Predictive Model and Sensitivity

The pre-contact period Native American archaeological sensitivity of the Pike Hill Mines Site is specifically based on the VDHP's environmental predictive model (VTEPM) for pre-contact settlement sites, ground-truthed using information collected during the walkover survey. In the fall 2006 the VDHP predictive model was enhanced with a GIS-based mapping and information system that consists of twelve map layers derived from a GIS-based geoprocessing model. These map layers represent environmental or cultural factors conducive to pre-contact habitation and resource extraction activities. A project area is assigned anywhere from one to ten environmental/cultural factors, although the numbered of scored layers do not necessarily mean that one area is more sensitive than another. The mapping layers are used to provide preliminary, coarse information about the Native American habitability of a given area.

For the Pike Hill Mines Site, the VermontArcheoMap was used as a complement to the VTEPM, in which individual variables are first grouped by class (River and Streams, Wetlands, etc.) and then assigned a positive or negative numerical ranking from -32 to +32. Using this score sheet, an area can be sensitized by determining the presence or absence of the specific variables, combining the associated scores, and comparing the total score to a predetermined valuation scale; a score of less than 32 is assessed as archaeologically non-sensitive while a total score of greater than 32 is considered archaeologically sensitive.

The VTEPM and the ArcheoMap layers provided only a rough approximation of the preliminary project APE's archaeological sensitivity. The field walkover survey took into account the presence of microenvironmental factors that would have affected pre-contact period settlement and/or survival chances of resources based on post-contact period land uses.

Because of the size of the preliminary APE (approximately 173 acres) and the diversity of environments contained within it, the Native American sensitivity assessments were divided into two regions (Figure 2-2). These regions were based on an environmentally derived division of the landscape:

- Area 1 (35 acres): Located on the northeast face of Pike Hill, including numerous terraces overlooking small stream drainages and wetlands associated with Pike Hill Brook. This area is farthest from the core industrial workings, and contains primarily the domestic subsites and access roads. It appears to be the least disturbed by post-contact period land uses. The VTDHP Archeomapping model indicates that this part of the site has three to four environmental/cultural factors contributing to archaeological sensitivity. The VTEPM assigns a score of 14 to this area.

- Area 2 (138 acres): Located at the summit and southeastern slopes of Pike Hill, extremely steeply sloped and rugged terrain. This area contains all of the industrial mine workings, including the mine shafts, adits, open cuts and prospecting pits/trenches. This area has been the most disturbed by post-contact period (mining) land uses. The VTDHP Archeomapping model indicates that this part of the site has one to two environmental/cultural factors contributing to archaeological sensitivity. The VTEPM assigns a score of -8 to this area.

Complete copies of the ArcheoMap layer for the Pike Hill Mines Site APE along with the VTEPM scoring sheets for each of the environmental regions within the preliminary project APE are included in Appendix D.

Euro-American Sensitivity Ranking

The presence of Euro-American archaeological resources within the project APE was primarily based on the intensive mining use of the site during the nineteenth and early twentieth-century. Historical maps and photographs of the mine site combined with the comprehensive walkover survey enabled a more precise on the ground identification of areas of intensive mine-related site use, versus areas where there was little or no documented mine-related extraction, processing, or habitation.

Nineteenth-century town/county atlas maps were also reviewed to identify any potential pre-/non-mining related resources within and adjacent to the project APE.

Based on the GPS survey and archival research a number of Euro-American industrial and domestic occupation areas were identified within the project APE. The majority of these historic occupation areas were grouped collectively within designated subsites, or vicinities of intensive occupation (Figure 2-3).

The subsites identified at the Pike Hill Mines Site encompass approximately 84 of the approximate 173-acre preliminary APE and consist of:

<u>Industrial Resources:</u>

- Union Mine (15 acres)
- Eureka Mine (including Ore Mill) (15 acres)
- Prospect Pits/Explorations (34 acres)
- Smith Mine (6 acres)

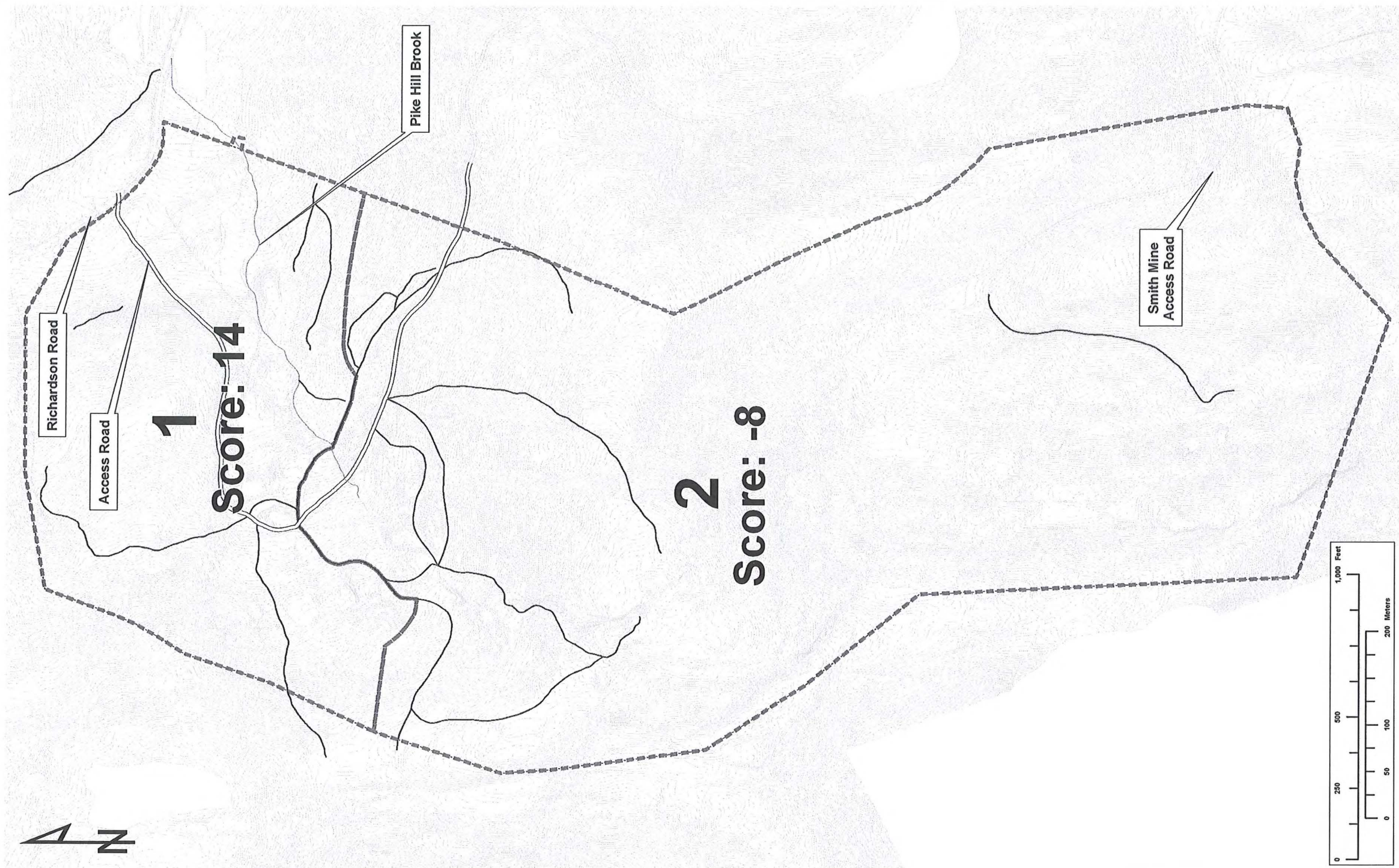

Figure 2-2. Map of Pike Hill Mines Study Area, showing prehistoric environmental predictive model regions.

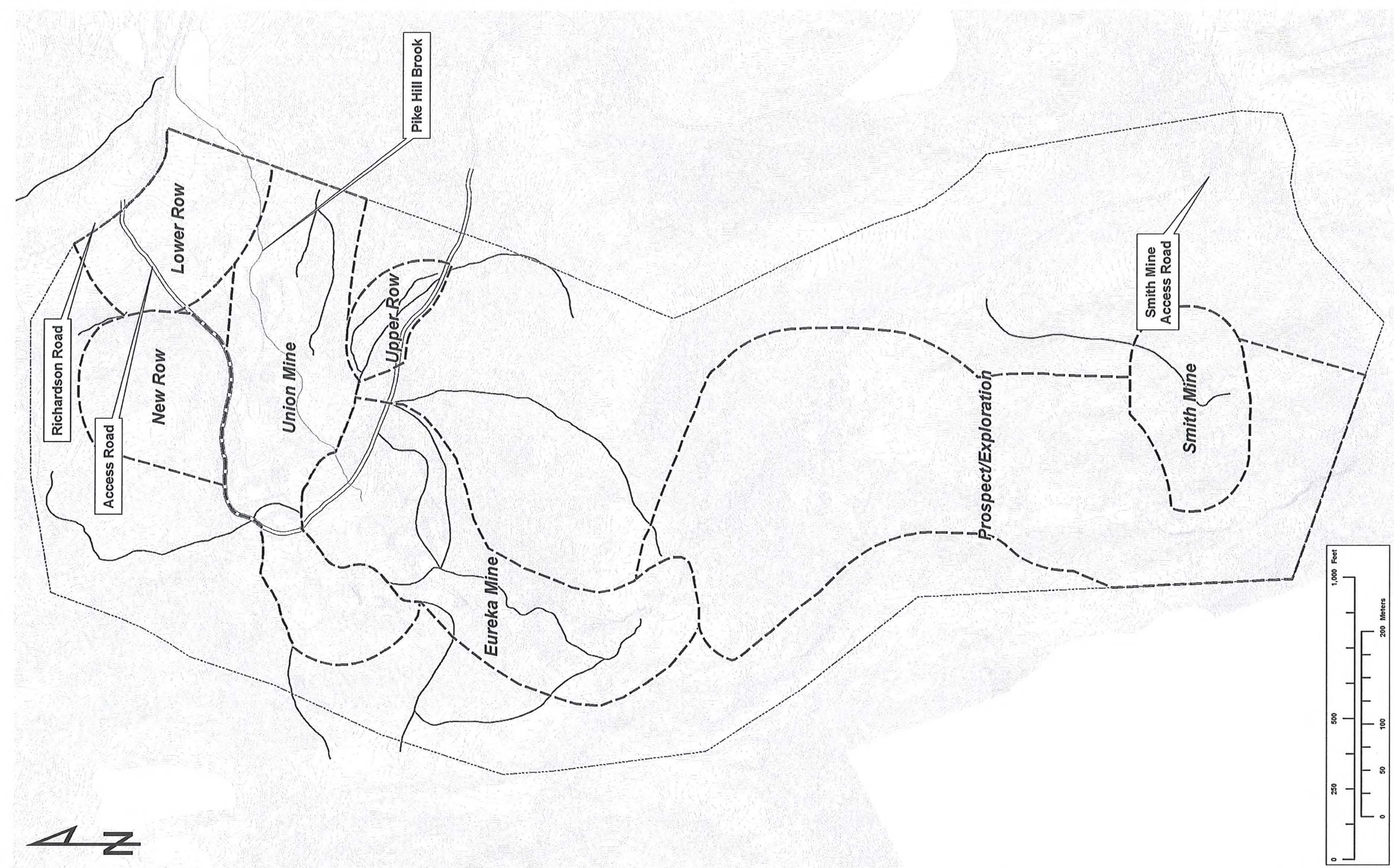

Figure 2-3. Map of Pike Hill Mines Study Area, showing identified post-contact period industrial and and domestic subsites.

Domestic Resources:

- Upper Row (2 acres)
- Lower Row (6 acres)
- New Row (6 acres)

While these subsites represent the majority of the visible cultural resources at the Pike Hill Mines Site, there are several peripheral features, termed isolates, situated along the northwestern side of the preliminary project APE. These include small prospect sites, stone walls, a granite quarry, and dam/reservoir. There is also evidence of the historical mine road system throughout and surrounding the subsites. Non-subsite total acreage is approximately 89 acres.

Subsurface Testing

The archival research, including application of the VTEPM combined with the walkover survey, determined that approximately 90 acres of the 173-acre project APE possessed moderate and high sensitivity for pre-contact and post-contact (mine-related) archaeological resources. This sensitivity acreage included the 35 acres (Area 1) identified as having the highest potential for pre-contact period habitation sites. Subsurface testing was also conducted in all of the domestic subsites and along terraces overlooking small stream drainages associated with Pike Hill Brook within the preliminary project APE. Subsurface testing was also conducted in the more remote area of the Smith Mine to the south.

A total of 90, 50-x-50 centimeter (cm) test pits were excavated as part of the historic and archaeological survey and mapping effort. This sampling strategy is equal to approximately one test pit per sensitive acre, which is the same testing intensity applied to the Elizabeth Mine and Ely Mine historic and archaeological surveys in 2001 and 2002, conducted by PAL under NAE and EPA authority (Table 2-2). Of the 90 total test pits, 73 test pits were excavated for historic mine-related resources and 17 test pits were used for pre-contact sensitivity areas (see Figure 2-2; see chapter 8). These test pits were placed at 8-m intervals along six judgmental transects (A thru F) and as judgmentally placed test pits (JTPs 1–63).

Table 2-2. Distribution of Subsurface Testing Conducted within the Preliminary APE, Pike Hill Mines Site.

SubSite Location	Sensitivity Assessment	Number of Test Pits
Union Mine Workings	Low	0
Eureka Mine Workings	Low	0
Prospect Trenches/Explorations	Low	0
Eureka Office	Moderate/Low	3
Union Office	Moderate/Low	3
Upper Row (Housing)	High	24
Lower Row (Housing)	High	19
New Row (Housing)	High	16
Smith Mine Workings	Moderate	8
Prehistoric Sensitivity Areas (Non-site)	Low	17
Total		90

All test pits were excavated by shovel in arbitrary 10-cm levels to sterile subsoil. Excavated soil was hand-screened through 1/4-inch hardware cloth, and all cultural materials remaining in the screen were bagged and tagged by level within each unit. The count and type of all recovered cultural material were noted. Soil profiles, including depths of soil horizons, colors, and textures, were recorded for each test pit on standard PAL test pit profile forms. All test pits were filled and the ground surface was restored to its original contour following excavation.

Detailed Drawings of Aboveground Structural Remains

The current study area (including preliminary APE) contains visible structural remains and landscape features, many of which were recorded with detailed plan and cross section line drawings. Structures and features that were spatially isolated, indistinct, or better represented elsewhere on the site (e.g., a reservoir NW of the New Row domestic subsite) were not subjected to detailed measured drawings. Plan maps, which show the spatial relationship of the various features of a resource, were created in CAD and GIS so that scales of various ranges can be attained when printing, depending on the size and complexity of the resource. Cross sections were employed to depict the topographic relationships between the various features as well as aspects of wall construction.

Plans and cross sections were completed by using a Leica Total Station to survey selected physical elements at an accuracy of less than 1 inch. In general the total station was used to establish a baseline and measurements and angles were taken relative to a number of datum points. A representative foundation for both the Lower and Upper Row domestic subsites was chosen, as well as the Union Adit and the Flotation Mill for survey with the Total Station. A rough 3D model of each site was rendered using the equipment and any number of the smaller cross sections and profiles, such as mine openings, could be viewed in a CAD viewer. In general, other plan maps were created using a hand compass and tape measure to establish the angles and distances between points within a resource. Given the slope and thick vegetation on the hill, in the case of the Flotation Mill, it was necessary to establish several datum points and shoot different angles and distances from different points.

The field maps were digitized using AutoDesk Map 3D 2007 and then were exported into the GIS database. Besides adding more detail to the GIS map, the field drawings permitted the data collected during the GPS survey to be corrected for greater accuracy.

Laboratory Processing and Analyses

Processing

All cultural materials recovered from the project APE during subsurface testing, and representative industrial-related artifacts collected from the entire site during the field mapping, were organized by subsite and provenience, and recorded and logged in on a daily basis. Cultural materials were sorted by type and either dry brushed or cleaned with tap water depending on the material or artifact type and condition.

Cataloging and Analyses

All cultural materials were cataloged into a custom computer program designed using a combination of *FoxPro 2.5* and *FoxExpress* database software. This program consists of a core of databases relationally linked to multiple material-type-specific databases that allow for in-depth analysis of cultural materials.

Materials that display similar attributes such as material type, functional and typological classes, size range, color, etc. were grouped and cataloged by lots. These lots were stored in 2-milliliter thick polyethylene resealable bags with acid-free paper tags containing provenience identification information. No pre-contact period cultural materials were recovered during the field investigations.

Post-contact period cultural materials were cataloged according to material (e.g., iron, ceramic, brick) and functional (e.g., industrial, agricultural, domestic) categories. Temporally sensitive artifacts, such as ceramics, were also identified in terms of type (e.g., whiteware, porcelain, stoneware) when possible. In addition, ceramic sherds and bottle glass were examined for distinguishing attributes that provide more precise date ranges of manufacture and use. These included maker's marks, decorative patterns, and embossed or raised lettering. Tentative dating of historic archaeological resources was performed using ceramic indices according to Hume (1969), Miller (1990, 1991), Miller and Hurry (1983), and South (1977). An analysis of the different nail and bottle types was used to refine the tentative date ranges of occupation generated by the ceramic assemblages. Additionally, faunal remains were identified based on their taxa and the portion of the animal represented.

The analyses of the cultural materials recovered during the archaeological survey also included mapping the density, horizontal, and vertical distribution of these materials within the project APE. Given the preliminary nature of the survey and the relatively small sample of cultural material recovered, analysis was limited to these basic tasks.

Curation

Following the laboratory processing and cataloging activities, all recovered cultural materials were stored in acid-free Hollinger boxes with box content lists and labels printed on acid-free paper. These boxes are being *temporarily* stored at the PAL facilities in Pawtucket, Rhode Island according to curation guidelines established by the U.S. Army Corps of Engineers.

CHAPTER THREE

ENVIRONMENTAL SETTING

The Pike Hill Mines Site is situated on Richardson Road off Pike Hill Road in the east-central part of the town of Corinth in Orange County, Vermont. The town of Corinth is located about 20 miles southeast of Montpelier and 10 miles northeast of Chelsea. The majority of the Pike Hill Mines Site is located in a broad, east-facing valley on the east slope of Pike Hill, the summit of which is at 1,965 feet above sea level (ft amsl). Pike Hill is located in a rural and forested area along the eastern flank of the Green Mountains. Pike Hill lies approximately 1.5 miles northeast of the Village of West Corinth. The total historic mine property encompasses about 216 acres, of which approximately 173 acres are included in the preliminary project APE. The historic lands associated with the Union and Eureka mines are on the east slope of Pike Hill. The much smaller Smith Mine is located about 1 mile to the south of the other two mines, on the southeast side of Pike Hill. It is connected to the larger workings on the east slope by a series of prospect trenches. Mine elevations range from approximately 1,640 ft amsl at the southern Smith Mine to 1,965 ft amsl at the summit of Pike Hill, which is the focus of the northern mines.

Geology and Geomorphology

Orange County is located in the northern portion of the Southern Vermont Piedmont Division of the New England Upland physiographic zone (Figure 3-1). The county is characterized by low, north-south trending glaciated ridges and stream-dissected valleys. The greatest topographic relief occurs on the western boundary at the east flank of the Green Mountain Division, and the eastern half of the county contains lower, rolling hills. Elevation varies from 3,166 ft on Butterfield Mountain in Orange, to about 400 ft at the Connecticut River, which forms the eastern boundary of the county (Sheehan et al. 1975:5).

The Pike Hill Mines Site is the northernmost mining site in the 20-mile-long, Orange County, Vermont, “copper belt” that includes the Elizabeth Mine at South Strafford and the Ely Mine at Vershire. These metallic sulfide mineral deposits are located in the Paleozoic stratigraphic units of the Connecticut Valley Trough that stretches from western Massachusetts to the Gaspee Peninsula. The bedrock underlying Orange County consists of Silurian and early Devonian metasediments with interspersed metavolcanics and igneous intrusives (Doll et al. 1961). These rocks were subjected to at least three stages of intense folding and metamorphism during the early Devonian Acadian (400 million years) orogeny. Rock units typically dip steeply to the east, and become progressively younger from west to east. The Pike Hill Mines orebody is hosted by the Waits River formation, which consists largely of metamorphosed calcareous pelite, pelite, minor quartzose metalimestone and metadolostone, and sparse calcite marble (seafloor sediments) (Figure 3-2). (Seal et al. 2001:116; Slack et al. 2001:194).

The Vermont copper belt ore deposits are examples of one of the major classes of metallic ore deposits found in the eastern United States, the group known as the Appalachian sulfides. These ore deposits consist of iron sulfide in the form of pyrite or pyrrhotite, often mixed with lesser quantities of copper sulfide, usually in the form of chalcopyrite, and sometimes zinc (sphalerite), lead, and trace amounts of

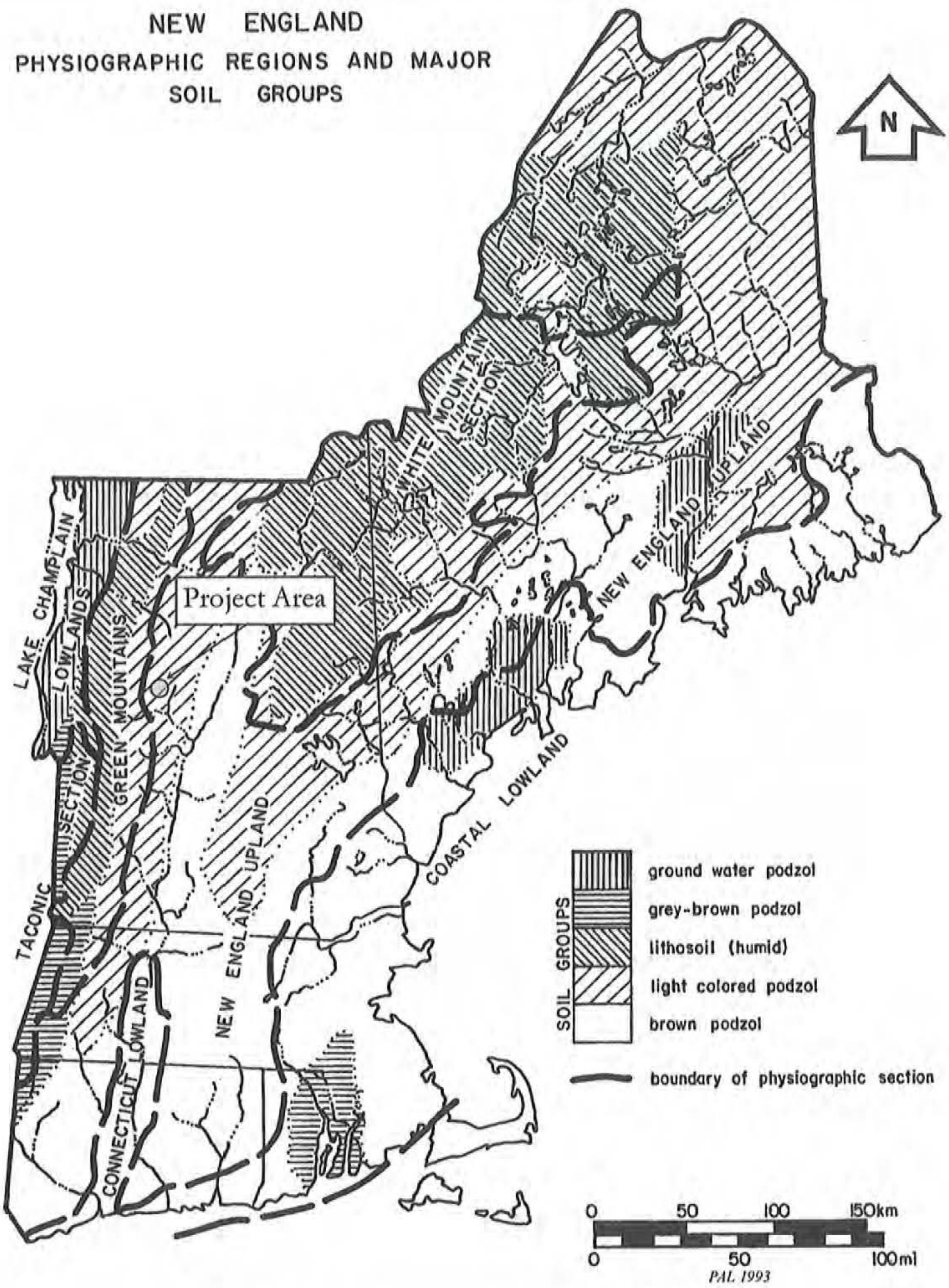

Figure 3-1. Physiographic zones of New England, showing the location of the Pike Hill Mines Site.

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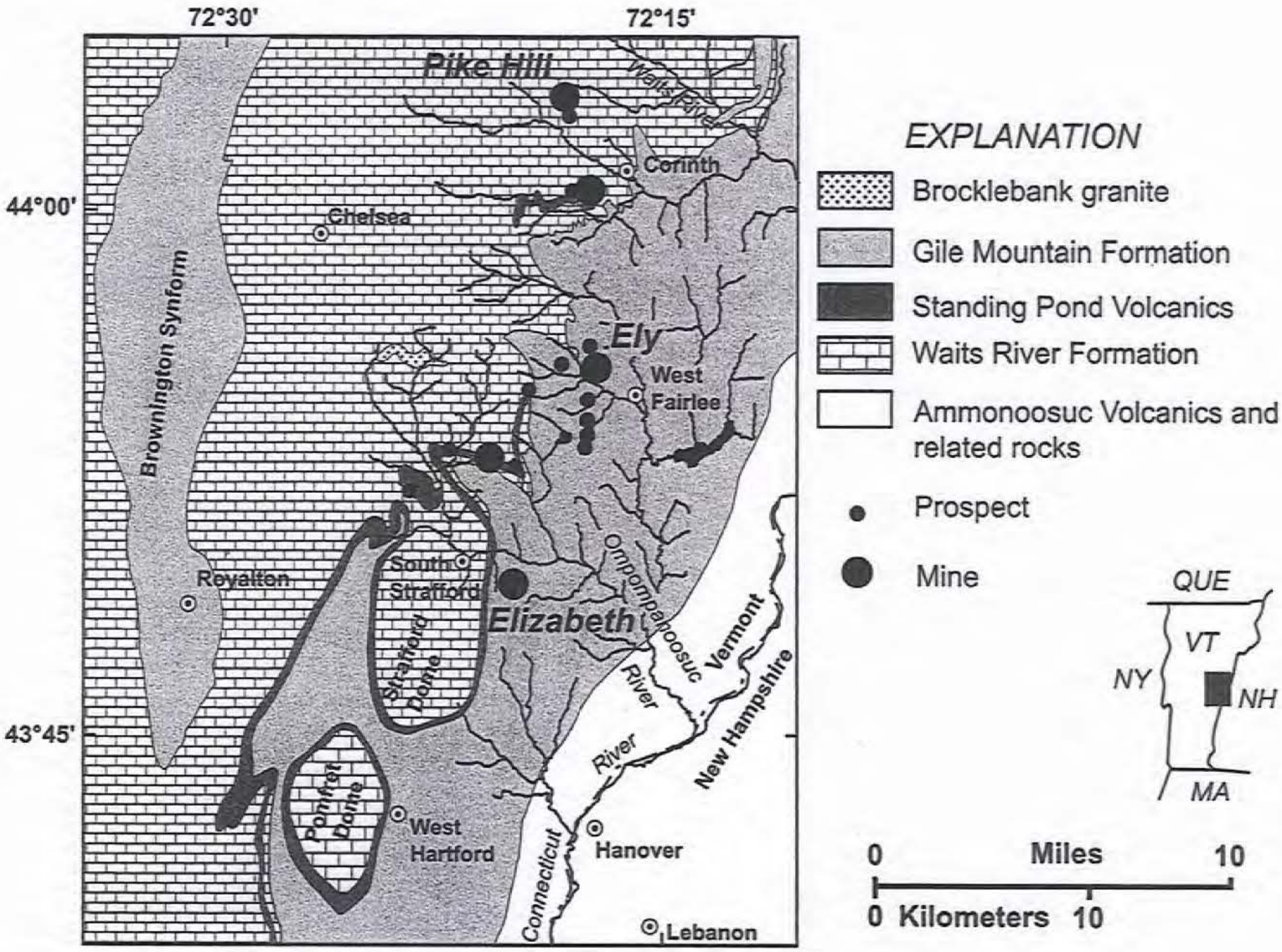

Figure 3-2. Generalized geologic map of the Vermont copper belt.

other, sometimes precious, metals. The Pike Hill ore consists mostly of pyrrhotite (iron sulfide) with the copper in chalcopyrite (copper sulfide), and traces of zinc and silver. Geologists debated the method of formation of Appalachian sulfide-type ore deposits for centuries until the advent of plate tectonic theory and the discovery of undersea hydrothermal vents. The orebodies are now generally understood to have been deposited on ancient seafloor as thick sulfide ore beds by hydrothermal vents that precipitated metals that had been leached from undersea magma by hot circulating seawater. The sulfide beds were eventually buried by sediments and incorporated into new continental crust in accretionary prisms where ocean crust was being subducted. The sedimentary and volcanic rocks were then included and metamorphically altered in the roots of folded mountain ranges, uplifted, and eroded, exposing them for discovery.

Appalachian sulfide deposits stretch from Alabama to Maine, and continue into New Brunswick. Ore deposits of this type are found all over the world, and are being deposited in submarine environments today (PAL 2000:3.6–3.7). The seafloor hydrothermal metallic sulfide ore deposits have been further classified into subgroups according to their original depositional environment. Geologists consider the Pike Hill Mines and other Orange County copper deposits to be examples of what is called a “Besshi” type massive sulfide deposit, named for its type locality in the Sea of Japan. These particular hydrothermal seafloor deposits are thought to occur at rifting (spreading) continental plate margins at oceanic ridge crests or back arc marine basins. The depositional environment of the Orange County deposits is considered analogous to that of the Gorda Ridge and Juan de Fuca Ridge in the eastern Pacific Ocean today, where exhalative hydrothermal vents are depositing sulfide-rich mats on spreading seafloor crust that are being buried by turbidite sediments from the proximal continental land mass (Seal et al. 2001:116; Sheehan et al. 1975:5; Slack et al. 2001:194, 196, 208–209).

The shape and orientation of the Pike Hill Mines orebody within its host rock was important to the historical development of the mine and its landscape. Appalachian sulfide orebodies are typically stratiform and stratabound, that is they conform to and are bound by their host rock layers, which were deposited at the same time. During the tectonic processes that emplaced them in their current location and orientation, they were subjected to intense deformation and remobilization. The orebodies that survived this activity are typically pod-like, lenticular, or tabular in shape, steeply dipping, and often swell and pinch or form overlapping lenses. They are generally massive and fairly sharply bound by their schistose host rock.

The three separate orebodies at the Pike Hill Mines are emplaced at the crest of a regional, north-south-trending cleavage arch, and straddle the summit of Pike Hill. The two larger orebodies extend from the summit to the north, on the east flank of the hill. The Eureka Mine worked the southern of these two orebodies, and the Union Mine worked the one to the north. Both orebodies consisted of several discontinuous, vertically stacked, irregular, lensoid, elongate, approximately 175 ft long, approximately 8 ft wide sheets of massive sulfide ore that plunged approximately 30 to 35 degrees to the east. The deposits measure approximately 1,200 ft (366 m) on strike (linear extent of surface exposure) and descend to a maximum depth of 700 ft (213 m) (Slack et al. 2001:197; Weed 1911:33; White and Eric 1944:25). Mid-nineteenth-century attempts to locate the main orebody and to determine its underground trend resulted in the excavation of the numerous prospect trenches across the top of Pike Hill. The earliest mine workings consisted of surface excavations, resulting in the linear open cuts trending north from the summit of the hill. Later, the ore was accessed by a series of horizontal adits and inclined shafts. The much smaller Smith Mine worked a smaller outlying pocket of ore on the south slope of Pike Hill.

Soils

Orange County was covered by a glacier during the most recent, late-Wisconsin time ice readvance about 13,000 years ago, and soils in the county have formed in glacial material since that time. Glacial erosion on ridges was minimal, however, scouring action of ice deepened and widened river valleys, which received outwash and glaciofluvial and glaciolacustrine deposits. Glacial till makes up approximately 92 percent of Orange County soils, and this cobbly, unsorted, nonstratified debris is distributed in a layer of varying thickness over the bedrock. The Waits River valley includes glaciofluvial features including kames and kame terraces, and glaciolacustrine littoral and lake-bottom deposits (Sheehan et al. 1975:5).

Soils in the vicinity of the Pike Hill Mines in Corinth are included in the Tunbridge-Woodstock-Colrain-Buckland association, which are gently sloping to steep, somewhat excessively drained to moderately well drained, shallow to deep, moderately coarse textured to medium-textured soils that formed in glacial till on hilly uplands (USDA 1978). The soils along the Pike Hill Brook drainage in the central and northern portion of the site (south of Richardson Road) are Buckland very stony loam, having 8 to 25 percent slopes. This sloping to moderately steep soil is found on the sides of hills and ridges in depressions and along drainageways. It is too stony for cultivation and is mostly used for woodland and unimproved pasture. The soils in the central and southern portions of the site around and including the summit of Pike Hill consist of Colrain very stony fine sandy loam, having 25 to 50 percent slopes and Tunbridge-Woodstock rock outcrop complex, having 8 to 25 percent slopes. The steep Colrain soils are found on hills and ridges and are too stony and steep for cultivations. Most areas of this soil are forested or have been cleared of trees for unimproved pasture. The Tunbridge-Woodstock rock outcrop complex contains sloping to steep soils and rock outcrop on hills and ridges. It is not suifor agriculture, and is mostly woodland or unimproved pasture.

The Pike Hill Mines Site includes large expanses of made land and disturbed soils. The colorful soils and variety of waste rock there are the result of copper ore mining, sorting, and waste rock disposal. The natural soils in peripheral processing areas including ore milling sites are also highly disturbed. The natural soils in worker settlement areas and associated agricultural lands have been modified to varying degrees by the post-contact and early modern period domestic occupations. The more wooded, steeply sloping and rocky areas of the site where little or no industrial activities occurred would be expected to contain undisturbed soil strata.

Flora and Fauna

The climate of Orange County is cool, temperate, and moist. Rainfall varies from 50 inches at higher elevations to less than 36 inches at White River Junction. The area experiences relatively long, cold winters and mild summers, with an annual average of 120 frost-free days. Forest vegetation in the county is typical of the temperate habitat of the Northern Hardwood Forest Formation of Vermont, and consists largely of American beech, sugar maple, paper and yellow birch, white pine, and hemlock. Game species include a variety of large mammals including white-tailed deer and black bear, and a variety of smaller mammals such as raccoon and beaver. Coldwater fish species include a variety of trout (Petersen and Petersen 1997:9; Sheehan et al. 1975:5; Thompson and Sorenson 2000:129, 145). Within the Pike Hill Mines Site itself, the vegetation reflects the acidic soil conditions. Some ravines and rocky areas host pockets of Hemlock Forest. Much of the tailings piles and associated drainage channels are barren of vegetation, and acid-tolerant species including birch and hemlock have begun to return to the periphery of these areas.

Drainage Patterns

The Pike Hill Mines Site lies within the drainage of Pike Hill Brook, a tributary of the Waits River, which is a major tributary of the Connecticut River (Figure 3-3). The Waits River is approximately 20 miles long in eastern Vermont. It originates in southwestern Caledonia County in the town of Groton and flows southeasterly into Orange County through the towns of Orange, Topsham, Corinth, and Bradford. The Waits River joins the Connecticut River in the village of Bradford. In Bradford it collects a short stream known as the South Branch Waits River, which flows easterly from Corinth. The northeast slope of Pike Hill is drained by the northeasterly flowing Pike Hill Brook. The brook flows for approximately 2 miles before entering a series of natural wetlands, then flows approximately 1.5 miles to its confluence with the Waits River, about 2 miles northeast of the Pike Hill summit.

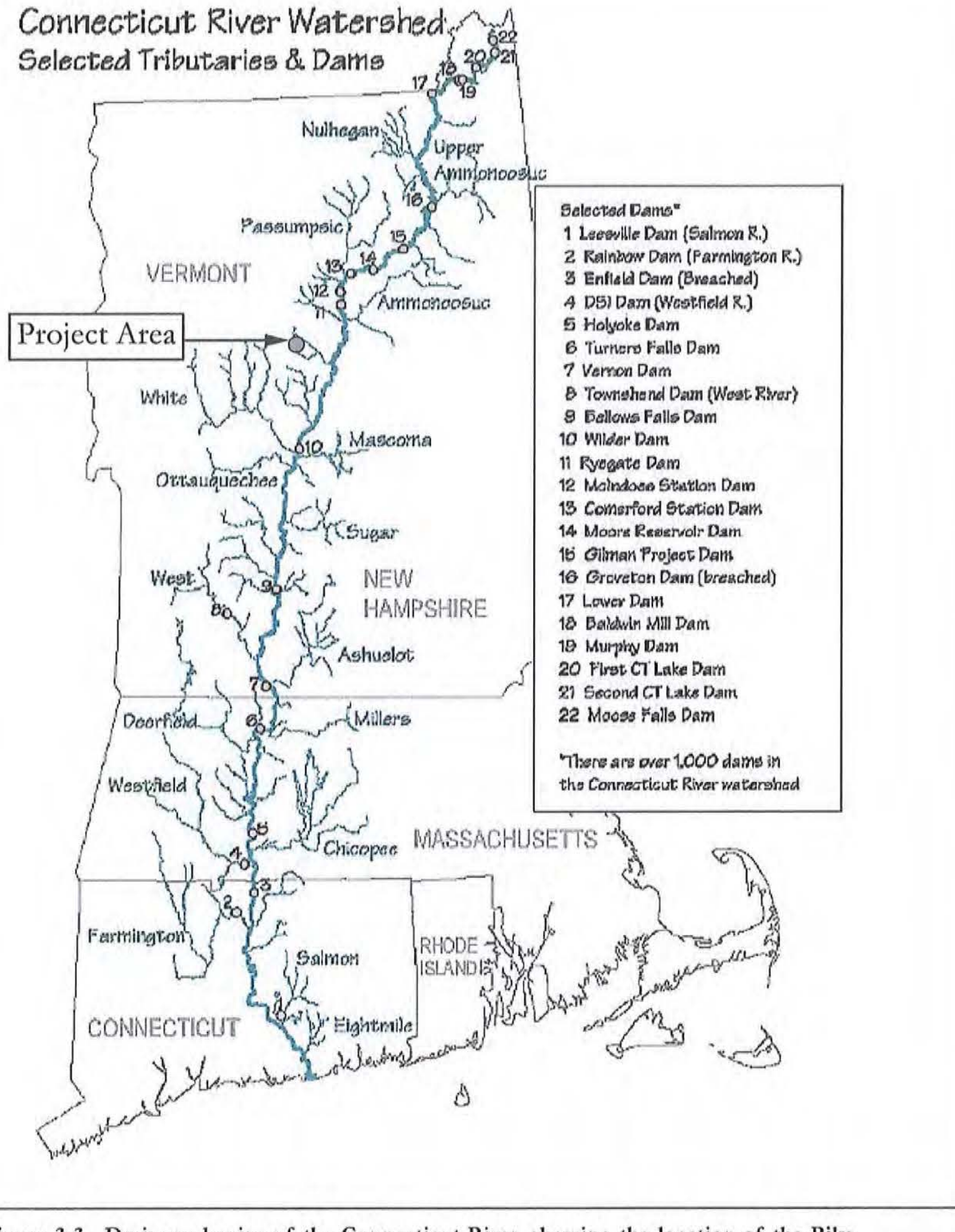

Figure 3-3. Drainage basins of the Connecticut River, showing the location of the Pike Hill Mines Site.

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CHAPTER FOUR

PRE-CONTACT AND CONTACT PERIOD CULTURAL CONTEXT

[N.B. The pre-contact cultural context for Pike Hill Mines was extracted from the Ely Mine historic and mapping survey report (Cherau et al. 2005). No pre-contact sites are recorded within a 2-mile radius of the Pike Hill Mines in the Waits River drainage. For the purposes of the current historic and mapping survey, the cultural context developed for the Ely Mine Site, situated approximately 9 miles to the south, provides a relevant and up-to-date account of pre-contact settlement and subsistence in this section of east-central Vermont].

The following discussion of pre-contact land use and settlement patterns in east-central Vermont is based on a synthesis of the extant archaeological data for this region. Previous cultural resource management surveys in east-central Vermont (Cox et al. 2001; Ohl and Potter 1992; Petersen and Petersen 1997; Thomas and Bourassa 1986) have determined that the pre-contact period culture history of the uplands region of the Connecticut River tributaries follows particular trends. These trends include a prominence of the Late Archaic, Middle and Late Woodland, and contact period cultures; and a paucity of evidence for PaleoIndian, Early and Middle Archaic, and Early Woodland cultures. This chapter presents the cultural chronology of Vermont prehistory, with an emphasis on sites discovered in east-central Vermont in proximity to the Orange County copper mines including the Pike Hill Mines Site**.**

PaleoIndian Period (9500–7000 B.C.)

The retreat of the Laurentide ice sheet in northern New England, beginning approximately 16,000 years ago, set into motion a series of profound environmental changes that shaped the landscape for the earliest inhabitants of Vermont. Glacial meltwaters formed end moraines that impounded massive lakes, including Lake Vermont in the present-day Champlain Valley and Lake Hitchcock in what is now the Connecticut River valley. By 10,500 B.C., erosion and/or isostatic rebound precipitated by the retreating ice mass breached many of the lake impoundments and, combined with the rising ocean levels, contributed to the development of inland seas (Ritter et al. 1995). The Champlain Sea covered approximately 20,500 square miles at its maximum extent but it, too, succumbed to the rebound phenomenon. By 8200 B.C., the land in northwest Vermont had risen far enough above sea level to cut off incoming tidal waters and effectively transformed the salt water Champlain Sea into freshwater Lake Champlain.

Archaeological evidence suggests that sometime before the Champlain Sea became Lake Champlain, possibly as early as 9300 B.C., the first human populations began to enter the subarctic environment of Vermont. During this period, the vegetative profile of the region was notably sparse, consisting of lichen, moss, and low-growing scrub growth. Exploianimal communities included elk, caribou, and mastodon, and likely played a major role in the diet of these early populations, hence the “Big Game Hunter” moniker often ascribed to them. Proximity to the Champlain Sea/Lake Champlain also may have spurred intensive marine and estuarine exploitation, while smaller game and plant gathering also likely played a large role in subsistence activities (Haviland and Power 1994; VDHP n.d.).

Settlement strategies during the PaleoIndian Period are poorly understood. Because of the range of variability at identified sites, large base camps, small residential camps, and very small task-specific loci have been advanced as the primary settlement models. Vail and Bull Brook I, covering several acres and yielding thousands of artifacts, serve as examples of the large base camp models, while the Reagan Site is a good illustration of a smaller residential camp. Dincauze (1993) has suggested that many of the large base camps like Bull Brook may have served as colonization centers or “marshalling camps” for the initial influx of PaleoIndian populations into the region, while the smaller camps represent exploratory forays from those more established settlements.

Data about task-specific sites remains elusive. The Hidden Creek Site (72-163) in southern Connecticut does offer some possibilities. Tentatively dated between 9,000 and 10,000 years old, the 34-square-meter (sq m) site is situated on a kame terrace along the edge of a swamp basin and yielded a lithic assemblage dominated by chert unifaces and endscrapers. The small size of Hidden Creek and its temporary nature suggest a highly mobile Late PaleoIndian population using few durable artifacts. It also suggests that these types of sites are highly ephemeral with low archaeological visibility and may often be missed because of coarse-grained excavation techniques and an overreliance on the use of fluted points as a diagnostic marker for the period (Jones 1997). The Varney Farm Site, a Late PaleoIndian site dating to 9400–8400 B.P. on the Nezinscot River in Turner, Maine, corroborates the latter point. The recovery of several non-fluted, parallel flaked chert projectile points with strong morphological similarities to Great Plains materials suggests that manifestations of the PaleoIndian Period in New England are too complex to be incorporated under a single diagnostic rubric (Petersen et al. 2000).

The best-known site in Vermont dating to the PaleoIndian Period is the Reagan Site. The roughly 2-acre site is located in East Highgate on a sandy bluff overlooking the Missisquoi River valley, and contains a varied artifact assemblage including diagnostic fluted points, knives, scrapers, gravers, hammer and anvil stones, and chipping debris. Lithic classes include chert, rhyolite, basalt, quartzite, jasper, soapstone, and talc, some of which derive from non-local sources and suggest fairly extensive movement of the site occupants across the landscape. The Reagan Site is unique among PaleoIndian sites for the recovery of 15 soapstone and talc “pendants.” Little is actually understood about the configuration and context of the recovered materials, as the site was not excavated in a systematic or professional manner. Nonetheless, the site is dated to the Late PaleoIndian based on the presence of several Plano-like points, and it is inferred that it was occupied repeatedly by a population focused on big-game hunting as the primary mode of subsistence (Haviland and Power 1994; VDHP n.d.).

The approximately 4.5-acre Mahan Site (VT-CH-197), situated along Allen Brook in Williston, dates to approximately 10,500 B.P. The artifact assemblage included fluted fragments, scrapers (spurred, end, and side), modified and utilized flakes, an abrading stone, choppers, drills fragments, and a knife. Projectile points were primarily made from local quartzite and chert, but exotic cherts and jasper were used to make many of the scrapers. The distribution of these artifacts suggests that while bone and/or wood materials were processed on a recurring basis, the intensity and types of processing undertaken varied with the residents. The site may be a single summer occupation by a large group. The number of artifacts recovered is evidence for a large group. The presence of exotic materials and the evidence of wood and/or bone processing dispersed throughout the site support this idea. If the site was occupied on a recurring basis, then it is expected that materials and artifacts would be clustered rather than dispersed. A summer occupation is supported by the paucity of projectile points. During the summer, food procurement would have focused more on collecting than hunting, requiring far fewer projectile points (Thomas et al. 1998).

Most PaleoIndian sites and find spots in Vermont are located in the Champlain Valley along the northwest margin of the state. St. Albans, Milton, Ferrisburg, and Addison all have yielded diagnostic fluted points, albeit in isolation, and suggest that a favored settlement option was along the sandy shores of the Champlain Sea during its period of maximum extent. Outside of the Champlain Valley, fluted points have been recovered from along Otter Creek in Brandon and from a ridge along a small stream in Moreton. It appears that PaleoIndian peoples preferred to travel north/south along the more lush western margin of Vermont and did not often venture into the rugged uplands of eastern Vermont (Thomas and Bourassa 1986:21) The Vermont portion of the Connecticut Valley has yielded no evidence of PaleoIndian occupation, but the Whipple Site, a PaleoIndian occupation dating to roughly 9000 B.C., was identified on a tributary of the Connecticut River in Swanzey, New Hampshire.

More recently, Richard Boisvert has published a series of articles about the Israel River Complex, a series of fairly large PaleoIndian sites located in Jefferson, New Hampshire, on the Israel River tributary of the Connecticut. Jefferson I-III (27-CO-28, 29, and 30) yielded diagnostic fluted points and channel flakes as well as chipping debris associated with tool production. Analysis of the complex and artifact assemblages suggests an innovative and flexible approach to projectile point manufacture in the Gainey/Bull Brook style, an eclectic lithic profile of local and non-local sources suggesting wide-scale movement throughout northern New England during the PaleoIndian Period, and a settlement profile focused on major river terraces (Boisvert 1998, 1999, 2000).

Other major PaleoIndian sites in northern New England include the 1-acre Vail Site in western Maine and the substantially larger Bull Brook occupation in Ipswich, Massachusetts. A string of such sites also has been identified within the Champlain/Hudson River valley in New York State including the Davis, Kings Road, West Athens Hill, and Dutchess Quarry sites.

PaleoIndian sites are scarce in general and even rarer in the Northeast. This is, in part, a real phenomenon generated by harsh environmental conditions in the region during that period. Conversely, the perceived scarcity also may be an artifact of limited survey work, differential preservation, a reliance on fluted points as the primary diagnostic marker of the period, and the possibility that many of the earliest sites are deeply buried under lake and river deposits.

Archaic Period

The Archaic Period in Vermont spans roughly 6,000 years and is marked by a gradual movement into and settlement of the region. Archaeological evidence suggests that settlement and subsistence patterns during this period are somewhat dynamic and shifting, and likely represent a response to the dynamic and shifting climatic conditions in the wake of the final retreat of the Laurentide ice sheet. On balance, the Archaic is poorly understood in Vermont as the database remains rather limited and few solid radiocarbon dates exist for those sites that have been identified.

Early Archaic Period (7000–5500 B.C.)

The Early Archaic in Vermont saw the end of the Wisconsin glaciation and a substantial temperature increase referred to as the Hypsithermal period (6000–1500 B.C.). During this time, average temperatures actually were higher than they are currently, and plant and animal communities reacted accordingly. Dry, warm summers and dry, cold winters encouraged the spread of pine-dominated forest, but also precipitated the decline of the megafauna populations on which earlier human communities had depended. In their place, smaller prey such as deer, bear, and other species recognizable to modern man emerged as well as a broader range of riverine, estuarine, and plant life that could not exist under the previously frigid conditions. Additionally, nut-bearing trees saw an increase during this period.

The lithic technology of the Early Archaic reflects this shift from a primary reliance on big-game hunting to a more diversified subsistence strategy. Corner-notched, stemmed, and bifurcate-based points serve as the diagnostic artifact class for the period and attest to a continued reliance on meat in the diet. The recovery of hammerstones, milling slabs, and notched pebble sinkers also indicate an increasing utilization of wild plant and fish resources. Also characteristic of Early Archaic assemblages is the predominance of expedient tools and the nearly exclusive use of local lithic sources, the latter of which suggests a more settled lifestyle. For all of their similarities, Early Archaic assemblages have the tendency to be highly eclectic in terms of their actual composition, reflecting the flexible and adaptive technological responses of a population confronted with a broad new range of environmental contexts (Haviland and Power 1994; VDHP n.d.).

Vermont hosts fewer than 40 Early Archaic Period sites in a range of environmental settings of which only six have been intensively sampled. For that reason, the settlement strategies of these people remain somewhat speculative (VDHP n.d.). By the end of the period, people were moving into the area using two overlapping settlement methods: “restricted wandering,” defined as seasonally based group movement, within well-defined territorial limits formed the basis for small residential groups foraging from one resource locus to another, and; “central-based wandering communities,” interpreted as a large band of individuals, perhaps as many as several hundred, spending an extended period of time in a single location to which they may or may not have returned at a later date (Ritchie 1969). That one form of settlement was categorically distinct from the other is unlikely, but the terms do provide general typological tools with which to interpret sites dating to that period.

The relatively low density of sites dating to the Early Archaic, particularly when compared to subsequent periods, have fueled the notion of commensurately low population densities. The low productivity of the early Holocene and, in particular, the low biotic productivity of the newly created Lake Champlain, have been cited as contributing factors. The identification of deeply buried Early Archaic sites on floodplains inside and outside of Vermont, including Bessette 2 and 3 on the Missisquoi River in northwestern Vermont, the Walnut Street Site on the Connecticut River in Gill, Massachusetts, and the Eddy Site at Amoskeag Falls on the Merrimack River in New Hampshire, suggest that this condition is more apparent than real.

The John’s Bridge Site (VT-FR-69), located on the Missisquoi River in Swanton, represents one of the better-known Early Archaic sites in Vermont (Thomas and Robinson 1980). Dating to about 5900 B.C., the small site contained five deep pits, a huge assemblage of chert, quartzite, and quartz chipping debris, and a collection of tools including 11 Swanton Corner-Notched projectile points, skinning knives, perforators, scrapers, and abrading stones. Significantly, the association of the Swanton Corner-Notched points with a clearly Early Archaic occupation confirmed a new diagnostic tool form for the period in addition to bifurcate based forms (Skinas 1992). Although no evidence of a shelter was unearthed, the density and distribution of cultural material and the spatial arrangement of a surface hearth at the site indicate that one did exist and likely was used as a workshop area for the production and repair of tools.

The Bessette 2 and 3 sites (VT-FR-140), located just upstream of John's Bridge in Highgate and dating to 5780 ± 70 B.C. and 6020 ± 270 B.C., respectively, are similarly restricted in size and scope. Bessette 2 yielded four typologically indistinct projectile points and more than 10,000 pieces of chert debitage, while Bessette 3 contained a shallow hearth, two bifurcate points and more than 200 pieces of chipping debris. The recovery of bifurcate base points from Bessette 3 is significant in that it illustrates the relatively rapid and extensive spread of Early Archaic tool technology from people living to the south along the Atlantic coastal plain, where the form is believed to have originated, to Vermont. Comparison of the two sites also underscores the range of camp sites organized by Early Archaic people, from a collection of residential base camps occupied for an extended period of time, as is the case at Bessette 2, to a small briefly occupied camp at Bessette 3 (Thomas 1997).

In addition to the abovementioned sites, bifurcate base points have been found thinly scattered throughout Vermont and, again, tend to be concentrated along the western side of the state, suggesting an overall settlement pattern analogous to the PaleoIndian. A bifurcate point was recovered from the Brooks Farm Site in St. Albans, while others have been recovered from the Connecticut River valley in the southeastern corner of the state. Swanton Corner-Notched points have been recovered from 14 sites in the Champlain Valley along the Otter Creek, Lamoille, and Missisquoi rivers, as well as near Shelburne Pond in the Winooski River watershed (Haviland and Power 1994).

Middle Archaic Period (5500–4000 B.C.)

The Middle Archaic saw a shift from the dry conditions of the preceding period to a climate characterized by significant increases in precipitation, perhaps as much as 25–30 percent higher than current levels (VDHP n.d.). Increased rainfall and snowmelt caused extensive flooding along major river systems as observed through rapid sedimentation sequences and channel migration along portions of the Missisquoi River floodplain. Vegetation patterns also shifted in response to the increased rainfall as the pine-dominated landscape gave way to a deciduous forest of oak, sugar maple, elm, ash, and beech, with smaller numbers of hemlock and white pine. With the emergence of this "mast" forest, deer populations expanded and likely became a major subsistence focus. Bear, wolf, otter, and wild turkey also emerged in greater numbers, while comparatively smaller populations of moose, elk, and caribou remained in the spruce-fir northern hardwood forests of the Green Mountains.

Sites in Vermont dating to the Middle Archaic Period are exceedingly rare, with fewer than 12 currently identified. This seems paradoxical given the increasing abundance and predictability of subsistence resources and may reflect a problem of recognition rather than a true absence of sites. The period is defined by three stemmed projectile points that have their origin along the Atlantic coastal plain including Neville, Neville Variant, and Stark. The Neville-type-site was identified by Dincauze in Manchester, New Hampshire and contained a substantial collection of these points, some with slightly bifurcate bases hinting at their Early Archaic lineage (Dincauze 1976).

Despite its northern New England identification origin, subsequent finds tend to be concentrated in southern New England. Middle Archaic sites are infrequent in the Champlain Lowland, south into the upper Hudson River drainage as well as in the upper St. Lawrence. To date, only a half dozen sites dating to this period have been identified in Vermont on the basis of Neville and Stark points. This infrequency suggests one of two scenarios: first, that Middle Archaic populations in Vermont shared a closer technological affiliation with the upper St. Lawrence-Great Lakes region than the Atlantic coastal plain and, as such, Neville and Stark points are not adequate diagnostic markers or, second; that there was an extremely small Middle Archaic population in Vermont.

Neville, Neville Variant, and Stark points often are found in association with steep-bitted scrapers, flake knives, perforators, adzes, axes, and choppers. Heavy woodworking tools also are common and suggest the appearance of dugout canoes during this period, perhaps a response to the increased river travel concomitant with increased precipitation. Excavations of a sealed, dated mortuary feature at Annasnappet Pond in Carver, Massachusetts also have conclusively linked the emergence of atlatl weights to this period (Cross 1999; Doucette and Cross 1997). Like the Early Archaic, informal tools appear to dominate the many Middle Archaic assemblages.

Settlement and subsistence patterns among Middle Archaic people in Vermont are difficult to infer because of the extremely limited database. The Fleming Museum collection yielded only three Neville points for Chittenden County out of a total assemblage of 5,000. To date, only six sites have been identified in Vermont on the basis of Stark or Neville points. Three of those points have come from amateur collections including the Benford Collection, which contained a Neville from Bomoseen Lake in southwestern Vermont, a Stark point in the Coane Collection from Salmon Hole along the upper West River, and another Stark in the Lathrop Collection from Batten Kill in Sunderland. A single Neville was reported from a mixed plow zone context at the Auclair Site (VT-CH-3) near the outlet of Shelburne Pond, while two possible Neville points also have been recovered from the shore of Lake Champlain in Ferrisburg. A terrace along Leicester River in the Otter Creek watershed yielded two additional Neville points and, finally, an isolated Stark point was found on an alluvial terrace adjacent to Otter Creek in Rutland (Thomas et al. 1983).

This limited database does suggest that Middle Archaic sites are oriented toward ponds, lakes, and rivers with an attendant emphasis on seasonal rounds. Base camps and residential camps are provisionally hypothesized, although physical evidence of houses or shelters has yet to be identified in the Northeast. The Neville Site in Manchester and the WMECO Site (19-FR-15) in the Riverside archaeological district in Gill, Massachusetts are both posited as base camps because of their locations on highly productive fisheries along major falls (Dincauze 1976; Thomas 1980). While such sites have not yet been found in Vermont, similar large camps are possible in analogous environmental settings, particularly at Vernon and Bellows Falls along the Connecticut River. All of the identified Middle Archaic sites in Vermont currently are believed to represent smaller residential occupations. Subsistence practices in Vermont during the Middle Archaic also are largely speculative, but based on information from WMECO and sites along the Lamprey River in New Hampshire and the Lund and Lindquist sites in Maine, a broad range of terrestrial and non-terrestrial resources were exploited including deer, shad, salmon, fox, otter, and bear.

Burial sites dating to the Middle Archaic are non-existent in Vermont, as is the case in all non-coastal areas of New England. If coastal burial practices are to serve as a guide, elaborate ceremonialism is characteristic of the period. L'Anse Amour, on the southern coast of Labrador, included a single individual buried face down with its head oriented toward the east and interred with a rich variety of ocher-stained grave goods. The Morrill Point burial complex in Maine and the Land burial site in Manchester, New Hampshire, both contained ocher-stained human remains, some of which had been cremated and all of which were interred with elaborate grave goods (VDHP n.d.).

Late Archaic Period (4000–900 B.C.)

Environmental conditions during the Late Archaic Period in Vermont are marked by a climatic shift to drier and slightly warmer conditions with a significant decrease in precipitation. River and lake flooding became an uncommon event as reflected in the lack of substantial alluvial deposits along the Missisquoi River as well as by a dramatic drop in the Shelburne Pond water table. During this period, oak, pine, and beech reached their full extent, while hemlock became much scarcer in response to the increasing dryness. Wetlands also became more abundant along river margins. Animal communities remained essentially the same as the preceding period, but it is likely that deer became even more plentiful with the full maturity of the mast forest, and that wetland/estuarine resources became an even greater subsistence resource.

Perhaps in response to an increasingly resource-rich natural environment, Late Archaic populations underwent a substantial growth spurt relative to previous periods. This growth spurt, in turn, spurred an elaboration of settlement and subsistence models as well as a diversification in lithic technology unprecedented in the pre-contact record. As a means to better categorize and interpret the many local expressions of Late Archaic culture, the period has been divided into three traditions.

Laurentian Tradition (3600–2400 B.C.)

The Laurentian tradition was first identified in New York on the basis of "Proto-Laurentian" lithic assemblages including broad side-notched points with ground bases. These points generally resemble Otter Creek and Brewerton side-notched points. These point types later were recognized as diagnostic of the period along with Brewerton corner-notched and Vosburg projectile points. The association of Otter Creek points with heavy woodworking tools has led many to suggest that Otter Creek points are more appropriately grouped with Middle Archaic populations, but it is just as likely that this point style was grafted onto an older tool kit during the Late Archaic. In addition to projectile points, ground slate blades, celts, gouges, plummets, and ulus also serve as distinctive diagnostic markers for the period.

Within the Laurentian tradition, three phases have been identified, referred to as the Vergennes, Brewerton, and Vosburg. Differentiated largely on the basis of diagnostic projectile points, the phases represent regional variations on the larger Laurentian tradition rather than unique or specific adaptations. While the three phases overlap, the Vergennes phase is the oldest and the base from which the Brewerton and Vosburg technologies subsequently developed. Specific durations for each phase are difficult to determine. It is probable that they were largely contemporaneous (Haviland and Power 1994).

The Vergennes phase is characteristic of Vermont and is best represented by the Ketchum Island, or KI, site (Ritchie 1968). Roughly 1 acre in size, the site is located on a small, rocky, wooded island within a swamp along Otter Creek near Rutland. The type-site for Otter Creek projectile points, the assemblage also comprised exceptionally robust atlatl weights, ulus, blades, choppers, celts, adzes, and scrapers fashioned from quartzite, slate, chert, and sandstone. A copper gorge also was recovered. Several hearth features, a roughly 15-ft-wide circular dwelling, and a single red ocher burial were identified as well. While the occupation duration and seasonality of KI is somewhat speculative, the broad range of stone tools at the site suggests a population fully exploiting a broad range of food resources. Furthermore, the collection of heavy woodworking tools indicates the production of dugout canoes, while the relatively restricted range of lithic raw materials indicates a preference for locally available stone.

Other Vergennes Archaic sites in Vermont include five more sites along Otter Creek (Otter Creek 1–5), one of which, Otter Creek 2, contained the secondary internments of one infant, three children, and two adults. Vergennes phase artifacts also have been recovered from the Auclair Site at Shelburne Pond, the Winooski Site, and from the Hoosic and Walloomsac river drainages along the western edge of the state. The Bridge Site, located outside of Vermont but still in the Champlain Valley, was identified through surface collections during expansion of a sand pit operation and shares an analogous environmental profile with the KI Site. Otter Creek points are well represented in the Sweeney Collection (Thomas 1979) and in the Balder Collection from the Hoosic drainage (Fisher et al. 1977).

VT-CA-77, recently located on a first terrace above the Connecticut River in Barnet, Vermont, likely dates to the Late Archaic Period with another occupation during the Middle Woodland Period (Heitert et al. 2002). A Levanna triangle point and two possible Brewerton points were recovered from the site, in addition to thick-walled, mineral-tempered aboriginal pottery. All of these artifacts were recovered from similar stratigraphic contexts. The site also contains a series of possible living floors and a heavily burnt hearth. Based on the presence of English stoneware, creamware, and lead window caming the site may have also been inhabited by early European settlers.

The Brewerton and Vosburg phases of the Laurentian tradition are poorly represented and, consequently, poorly understood in Vermont. It is assumed that many of the basic patterns of the Vergennes phases, namely the exploitation of varied ecological niches and the pursuit of seasonal rounds, continued during these phases (VDHP n.d.). Brewerton projectile points are numerous in the Sweeney Collection, and one of the Green Mountain National Forest sites contained Brewerton points (VDHP site files).

Narrow Point Tradition (2400–1600 B.C.)

This tradition, also known as Small Stemmed, is distinguished by the presence of relatively long and narrow-bladed projectile points with generally weak shoulders and straight, expanding, and side- or corner-notched stems. These points tend to be made from locally available materials, often quartz, and are abundant in both southern and northern New England. Variants of the narrow point/narrow stemmed projectile point type include Lamoka, Bare Island, Wading River, Sylvan side-notched, Sylvan Stemmed, and Normanskill and occur in every major watershed in Vermont. None of the points, however, have been securely associated with a single component site.

Artifact assemblages dating to this period tend to be less diverse than during the Laurentian. Knives, drills, side and end scrapers, pestles, choppers, and hammerstones occur but in less eclectic groupings and there are significantly fewer ground-stone woodworking tools, suggesting a shift away from dugout canoes toward bark canoes in regions where birch trees were supported. Settlement occurred in a wide variety of locations including elevated bluffs, rockshelters, inland streams and lakes, and the backcountry, all of which suggest a continuation and intensification of broad-based resource exploitation. During this period new settlement patterns also begin to emerge, including a more intensive use of marginal uplands and the occupation of upland ridges in the Winooski and Wells River watersheds as well as secondary to minor stream valleys in the lowlands.

Susquehanna Tradition (1800–800 B.C.)

This latest tradition of the Late Archaic is also referred to as the “Broadspear” or “Transitional/Terminal” Archaic. Diagnostic projectile points include large, broad-bladed stemmed points (Atlantic, Snook Kill, Perkiomen, Genessee, and Susquehanna Broad) as well as smaller “fishtail” points with expanding stems (Orient Fishtail). Flat bottomed, lug-handled soapstone vessels also appear during this period, often in association with Susquehanna Broad and Orient points, and evidence suggests that some of the earliest fired ceramics may date to this time as well. Known as Vinette 1, these earliest pots were coil built with concoidal bases and finished with cord-wrapped paddles. Atlatl weights, end and side scrapers, expanded-base drills, retouched flake knives, pestles, notched sinkers, whetstones, and hammer-anvil stones round out the Susquehanna assemblage for Vermont, although grooved axes, adzes, gouges, and paintstones have been recovered in association with Orient points on Long Island.

Settlement patterns appear to have shifted at approximately 1000 B.C. in response to a shift in the regional climate. Cooler and wetter conditions precipitated a dramatic decline in the deciduous canopy and a return to a hemlock, pine, and birch dominated landscape. With the decline of the mast forest came a commensurate decline in the animal species dependent on it, namely deer, and it is probable that the subsistence diversity that characterized the previous traditions began to contract. Based on archaeological evidence or, more properly, lack of evidence, upland areas seem to have been used less and less until by roughly 800 B.C. that ecological niche was virtually abandoned.

Burial ceremonialism became exceptionally elaborate and complex during this period, particularly as it was manifested in the Orient phase around Long Island Sound. In that area, Fishtail points have been identified in association with single and communal cremation and inhumations on high hilltops, with the human remains and grave goods covered with red ocher and the inclusion of ritually broken, or "killed" soapstone vessels. No burials dating to the Orient phase have been identified in Vermont. However, an unusual burial complex was identified on Isle La Motte at the northern extent of Lake Champlain. Referred to as Glacial Kame burials, the interments were discovered during graveling operations. Two in situ burial pits containing the cremated and ocher-stained remains of six individuals were identified along the gravel ridge. Elaborate and exotic grave goods also were interred in the pits including "killed" sandal sole gorgets, circular shell pendants, copper, unworked galena, and disc beads (VDHP n.d.). This burial complex is unique in Vermont and appears to have diffused into the region from the north and west.

Susquehanna tradition sites are comparatively rare in Vermont and tend to be concentrated along the western border of the state in plow zone or multicomponent contexts. Orient phase components have been identified in small numbers throughout the Champlain Valley including at the Auclair, Donovan, Otter Creek No. 2, and Rivers Sites. Possible house pits associated with this period have been identified at the Cloverleaf Site in Bennington, which was dated based on radiocarbon dates. VT-CH-384, located on the Winooski River in Williston, is one of the few intensively sampled Susquehanna tradition sites in Vermont. The site was later occupied during the Late Woodland Period (Thomas et al. 1998).

Only one single component Susquehanna tradition site has been identified in Vermont, the Orient phase Highgate Converter Station Site (VT-FR-61) on the Missisquoi River in Highgate (Thomas and Dillon 1985). Dating to roughly 1200 B.C., the site yielded an assemblage of nine flake tools, chert chipping debris, a projectile point tip, and a chert preform, and is interpreted as the remains of a small hunting camp. Susquehanna sites are even less visible in the Connecticut River valley, and those that have been identified tend to be deeply buried by alluvial deposits. The Sumner's Falls Site in Hartland, dating to ± 800 B.C., contained Orient Fishtail points and a steatite cooking pot, while surface collection in the Skitchewaug area in Springfield resulted in the recovery of soapstone vessel fragments.

The point type of the same name defines the Snook Kill Phase. The largest Snook Kill component identified to date in the Hoosic River drainage is at the Weir Site (Funk 1978). Both Snook Kill and Genessee points are included in the Sweeney Collection, most notably from the Rudd Site (VT-BE-12) (Hasenstab and McArdle 1988; Thomas 1979). The Hudson Orient Phase, represented by Orient Fishtail and Susquehanna Broad projectile points along with soapstone (or steatite) pottery vessels are also present in the Sweeney Collection from the Hoosic River drainage.

Woodland Period

The Woodland Period in Vermont is marked, in the earliest phases, by a remarkable degree of continuity with the previous Archaic traditions. By the end of the period, a series of dramatic developments, including the development of horticulture and the earliest contacts with European populations, changed Native American lifeways in a profound way.

Early Woodland Period (900–100 B.C.)

Climatic conditions during the Early Woodland remained essentially the same as those that marked the Late Archaic Period after 1000 B.C. Cooler, wetter conditions encouraged the decline of nut-bearing vegetation in favor of hemlock, pine, and birch and imposed limits on the biotic carrying capacity of the region relative to earlier periods. Human populations in Vermont responded to this change by continuing a broad-based hunting and gathering strategy but one more explicitly oriented toward rivers, lakes, and ponds with limited seasonal use of upland settings. In short, general cultural settlement and subsistence patterns did not change dramatically from the Late Archaic to the Early Woodland. The Missisquoi, Lamoille, Otter Creek, Lemon Fair, and East Creek drainages on the western side of the state all served as settlement foci as did, to a lesser extent, the Connecticut River valley to the east. Group sizes are assumed to have been relatively small, perhaps between 30 and 50 people that in some cases splintered into even smaller residential camps of 5–15 individuals.

Diagnostic cultural materials for the Early Woodland include stemmed and side-notched Adena and Meadowood projectile points. Both point types are relatively rare and tend to occur in small numbers within Early Woodland assemblages. Lagoon points are also indicative of the period, but only have been provisionally identified in western Vermont, as they are far more common in southern New England. Lithic assemblages for this period comprise a high percentage of "exotic" lithic materials, including Munsungen cherts from northern Maine, and speak to an expansion and elaboration of long-distance trade networks. Low-fired Vinette I pottery, which seems to make its first appearance during the Late/Transitional Archaic, also becomes much more visible in the archaeological record during this time.

Once again, the occurrence of Early Woodland occupations in Vermont is low. Some have suggested that this low density of sites, not just in Vermont but also throughout New England, indicates a population decline associated with any number of causal factors including unfavorable environmental conditions, "unknown prehistoric epidemics" (Fiedel 2000; Mulholland 1988; Snow 1981; Wendland and Bryson 1973). This assertion may be more a function of a lack of recognition of Early Woodland components from a cultural material perspective than a real decline in numbers. This idea receives some support from the fact that several Early Woodland components in Vermont, including a hunting camp stratum at the Highgate Converter Station Site, contained no diagnostic artifacts but rather were dated on the basis of radiocarbon dates (Thomas and Dillon 1985).

Other Early Woodland components in the Champlain Valley were identified in the Pearl Street Park Site (VT-CH-234) near the headwaters of Sunderland Brook in Essex and the Ewing Site on Shelburne Pond. The former was identified on the basis of a broken Meadowood point, Vinette I ceramics and a resharpened lobate-stemmed point all made from non-local gray to dark gray chert, while the latter was radiocarbon dated to 765 ± 135 B.C. using the remains of ritually consumed dog. While no additional diagnostic material was recovered from Ewing, the recovery of a broken Meadowood from the nearby Auclair Site confirms an Early Woodland presence in the area. An Early Woodland component also was recently identified with the recovery of a possible Meadowood point at VT-CH-201 in Colchester. This site, located between the Winooski River and Mallets Bay, was originally identified in the 1980s during a survey for the Chittenden County Circumferential Highway, has yielded evidence of occupation in the area from 2,500 B.C. to A.D. 1000 (Toney 2001). The Swanton Route 78 Site includes at least three large campsites or villages dating to the Early, Middle, and Late Woodland Periods. These sites are still under investigation but have produced ceramics, stone tools, and features.

The Canaan Bridge Site, radiocarbon dated from 910–370 B.C. with a mean date of 635 B.C., provides the most detailed data about the Early Woodland from a residential context on the Connecticut River (Bolian and Gengras 1991). Located close to the Canadian border, the site was occupied repeatedly during the Early Woodland and yielded several shallow hearths, Vinette I pottery fragments, a red chert Meadowood point, chert flakes and knives, grinding stones and slabs, and a fragment of a highly polished ground-stone pendant. Overall, artifact densities were low, but the predominance of exotic cherts reinforces the expansion of trade networks during this period. The Skitchewaug Site in Springfield is another large, complex, multicomponent site along the Connecticut River containing a deeply buried Early Woodland occupation dating to 720 ± 70 B.C. This level yielded a side-notched point, a broken cache blade, a reworked unifacial scraper, and Vinette I pottery fragments (Heckenberger and Petersen 1988).

The evolving trade network that resulted in the predominance of non-local lithic materials in many Early Woodland assemblages might also explain the increasingly elaborate and exotic mortuary complex that developed during the period. What is remarkable about the Early Woodland is the degree to which it is defined by mortuary data, particularly in light of the relative paucity of domestic sites dating to the same time. Defined on the basis of New York typologies as the Middlesex mortuary complex (Ritchie 1969), four such cemeteries have been identified in the Champlain Lowland including Boucher (VT-FR-26), Swanton (VT-FR-1), East Creek (VT-AD-26), and Bennett (VT-AD-298).

Of these four sites, Boucher is the most thoroughly documented, containing 84 pit features positively identified as burials and an additional 18 pits presumed to have contained human remains that have since completely disintegrated (Heckenberger et al. 1989). Based on a range of radiocarbon dates from 885–100 B.C., the area is believed to have been used throughout the Early Woodland and contains a wide array of burial practices and grave goods. Cremations and inhumations, secondary interments, and flexed burials all were identified, as well as a spectacular array of exotic grave goods including Ohio steatite blocked-end tubular pipes, Meadowood and Adena points, amulets, plummets, birdstones, gorges, and pendants. Three complete but broken Vinette I vessels were recovered and are rare because of their incised decoration. Bone needles, punches, and fish hooks; shell beads and pendants; and copper awls, celts and rolled and tubular beads; also were excavated. The inclusion of copper provided a positive preservation environment that allowed for the recovery of hide and plant fiber artifacts including medicine bags, cordage, mats, and shrouds. Osteological analysis of the human remains indicated a relatively healthy population that subsisted primarily on meat and fish but did suffer from a high, but not unusual, degree of pre-adult mortality. Overall, analysis of the Boucher assemblage reveals a largely egalitarian society with strong trade extraregional trade networks and strong, well-developed spiritual beliefs, particularly in regards to the treatment of their dead.

Middle Woodland Period (100 B.C. –A.D. 1050)

Beginning about 150 B.C., the climate appears to have stabilized as the previously damp and cold environment gave way to generally drier and warmer conditions. If the number of identified sites is any guide, it appears that population densities increased during this period as well, but aggregated almost exclusively in the Champlain and Connecticut River valleys. This population expansion may have overtaxed the subsistence resources of the changing environment and led to a more diffuse hunting and gathering strategy that saw a return to a more intensive exploitation of the uplands. In general, summer villages were located in the lower reaches of almost every major river with upland habitation sites prevailing in winter, spring, and fall.

Pottery style and decoration became far more deliberate and stylized than is evident in the preceding period, although there are no comparable examples of the dramatic Middlesex mortuary complex. The elaboration of pottery design may take its cue from the population expansion hypothesized for the period, in which a diversity of groups may have felt a cultural imperative to distinguish themselves from one another through decorative motifs.

The Middle Woodland is the best-understood pre-contact period in Vermont (Atwood 2000:V-5), thanks to several excavations in the Champlain Lowland. Perhaps for this reason, the period has taken on a degree of interpretive complexity that has resulted in the creation of four phases including the Winooski, Fox Creek, Intervale, and Colchester. Like the phases defined for the Late Archaic Period, these phases tend to overlap if not coincide with one another, and reflect regional variation on a basic adaptive suite. The Winooski Site, located on the east bank of the Winooski River close to Lake Champlain, has become the type site for the period in western Vermont and contains evidence of three of the four phases. Middle Woodland Period sites also are expected for the eastern part of the state, particularly within the Connecticut River valley. The Skitchewaug Site in Springfield, for example, contained a Fox Creek Point, several Levanna points, and pottery with close stylistic affinities to Middle Woodland forms found in northern New England drainages, suggesting at least occasional utilization of that area. VT-CA-77 contained a Levanna point and thick-walled aboriginal ceramics, in addition to possible living surfaces and a hearth.

Winooski Phase (100 B.C.–A.D. 300)

Winooski phase settlements tend to cluster near riverine, lacustrine, and wetland environments with an obvious exploitation of the available resources in those environments. The Winooski Site yielded evidence of deer, domestic dog, fish, bird, and mammal bone as well as butternut, pigweed, and bedstraw (Petersen and Power 1983). Similar remains have also been recovered at the Donovan, East Creek, Ewing, Mudgett Island, Otter Creek No. 2, and Sunderland Falls sites, but because of mixed stratigraphic contexts, a clear association with the Winooski phase or clear indications of seasonality cannot be determined.

Residential sites are assumed to have been rather small and reflect a restriction of the wandering community pattern so common during the Archaic. The Oxbow Type A projectile point is believed to be diagnostic of the period and it appears that lithic assemblages comprise mostly non-local materials, suggesting the continuance of long-distance trade networks. Grit tempered, coil built cylindrical and slightly bulbous vessels with pointed bottoms define the ceramic form and are generally well fired. Decorative motifs include stamps and incisions from the neck to base, with a pseudo-shell motif present on all vessels recovered from Winooski. Other sites include similar design elements with the inclusion of dentate decoration.

Fox Creek Phase (A.D. 300–500)

Fox Creek phase sites in Vermont are rare; no such phase was identified at the Winooski Site, but it is documented in New York. The closest comparative example to this phase in Vermont is VT-CH-201, located on a small tributary of the Winooski River in Colchester. The riverine setting is typical of the phase as is the artifact assemblage that included diagnostic Fox Creek stemmed projectile points, a chert preform, and fragments of two chert drills. Grit-tempered pottery with dentate and pseudo-scallop shell decoration also was recovered. The site has been interpreted as a small residential settlement as were two other similar occupations, VT-FR-7, located on the lower Missiquoi River, and VT-CH-127, identified on a narrow terrace below the Winooski Falls.

Intervale Phase (A.D. 500–800)

Settlement patterns during the Intervale phase are similar to those of the Winooski and Fox Creek phases, and include small residential and base camps focused on riverine and wetland environments. Most of the identified sites in Vermont have been identified on the lower reaches of the Missisquoi, Otter Creek, Lamoille, and Winooski rivers although additional sites have been located near Shelburne and Bristol ponds.

A broad range of animal and plant remains was recovered at the Winooski Site including deer, sturgeon, muskrat, butternut, hickory, and black walnut, suggesting a summer through fall occupation. Other combinations of food remains at Bessette I and Sunderland Falls suggest a similar seasonal occupation. Bessette I also may contain evidence of an extended spring through late fall occupation. What all of this data suggests is a return to a restricted wandering pattern during this period and an increased exploitation of many environmental niches by large and small groups. VT-WA-35, a small site located on a narrow terrace above the Winooski River in Moretown, likely represents an extremely short-term “stopover” site used to take advantage of a seasonally specific resource, and bolsters the idea of a diffuse subsistence strategy (VDHP n.d.).

Technologically, Jack’s Reef Corner Notched projectile points function as the most diagnostic artifact for this phase, although Levanna and Jack’s Reef pentagonal points also are common. Raw material types derive from both local and non-local sources. Coiled and grit-tempered ceramics are common in Intervale assemblages but, as was noted at the Winooski Site, tend to be of lower quality with commensurately lower survival rates in archaeological assemblages. Surviving fragments, however, exhibit a characteristic wavy line decoration that may be diagnostic for ceramics dating to that time.

Evidence for a large residential base camp has been recovered at the Reynolds Site on the Missisquoi River, while the Knapp Site on Lake George represents a small extractive or processing station site. Additional extractive station components also have been identified at Otter Creek No. 2 and several sites near the Winooski Falls, all of which suggest a diversity of sites and functions for the Intervale phase. Evidence for the period is quite sparse for the southwestern part of the state. Jack’s Reef Corner Notched points have been recovered from the Hoosic and Walloomsac valleys as part of the Sweeney Collection, but no inferences concerning settlement or subsistence patterns can be inferred from that data.

Colchester Phase (A.D. 800–1050)

Sites dating to the Colchester phase are found in a wide variety of environments. Large sites tend to be located on the floodplains of the lower reaches of the Winooski, Lamoille, and Missisquoi Rivers and

Otter Creek. Smaller sites occur on the upper reaches of those same rivers as well as along the Hoosic and Wallomsac Rivers, small streams like Sunderland Brook, and along the edges of Shelburne Pond (Ewing and Palmer sites) and Lake St. Catherine and Lake Bomoseen. Based on this distribution model, settlement strategies clearly revolved around riverine and lake resources with an increasing emphasis on the uplands.

Levanna points appear to be characteristic of the period as are bone fishhooks, gorges, awls, and needles as deduced from excavations at the multicomponent river site at the mouth of Dead Creek. What is unusual about lithic assemblages during this period is the near-exclusive use of local raw materials such as local quartzite and Champlain Valley chert. This pattern was observed at the Winooski Site as well as at the McNeil Site and McNeil Borrow Site across the river. This shift from exotic to local materials may reflect a hardening of territorial and cultural boundaries between native people in the Hudson Valley and groups in Vermont (Peterson and Power 1983). Grit tempered, coil built pottery, stamped and undecorated, dominates the ceramic profile in this phase.

Late Woodland Period (A.D. 1050–1600)

The Late Woodland represents a period of both continuity and innovation, one in which lithic technologies, an interpretive mainstay in archaeology, underwent very little change, while at the same time the development of horticulture dramatically altered the social and cultural landscape for Native American communities. During this period, archaeological and ethnohistoric literature begins to make reference to distinct Native American communities, for example the Iroquois and Abenaki. This distinction is not arbitrary but appears to reflect increasing levels of self-identification among these populations as reflected in distinctive ceramic styles and restricted trade networks relative to earlier periods.

While the number of identified Late Woodland sites is rather low, the distribution of these sites is far more evenly spread along the eastern and western boundaries of the state than is the case for the preceding periods. Large habitation sites appear to be concentrated along major river valley corridors, including the Champlain and Connecticut River valleys, a phenomenon that likely reflects the increased desirability of floodplain environments for horticultural purposes. The multicomponent Skitchewaug Site in Springfield, located along the western bank of the Connecticut River, has yielded some of the most detailed and informative data about the period and, in view of its environmental similarity with similar sites in the Champlain Valley, will serve as the descriptive basis for the Late Woodland in Vermont.

The adoption of horticulture is undoubtedly the most significant cultural adaptation during the Late Woodland, and had serious, identifiable repercussions for nearly every other aspect of Native American life during that time. After the introduction of maize in ca. A.D. 1050 (Thomas and Bourassa 1986) settlement patterns became markedly more sedentary from A.D. 1100–1450 and residential groups became larger. Villages comprising small hamlets adjacent to cultivated fields began to emerge during this period and appear to have been occupied during the growing season. Skitchewaug yielded carbonized maize, beans, and kernels dating as early as A.D. 1100 and contained the deeply buried remains of two semi-subterranean pit structures (Heckenberger et al. 1989; Heckenberger et al. 1992). These 4–6-m-wide oval structures are visible as a series of superimposed living floors separated by what are likely sterile flood deposits. House Pit 1 appears to have been occupied as many as 14 times and was peppered with deep storage and refuse pit features.

Similar structures have been identified upriver in Windsor and Fairlee. A third site in Orange County also contained a series of dark organic living floors stratigraphically separated by subsequent flood deposits, but these living floors are considerably larger than at Skitchewaug, in some cases stretching as far as 24 m in length. The Donohue Site (VT-CH-94) on the Winooski Intervale in Burlington, also contained the remains of a residential hamlet similar to that unearthed at Skitchewaug, although with less clear-cut evidence of habitation structures.

The excavated storage pits at Skitchewaug provide confirmation of the primacy of horticulture for the families living at the site and also provided clues to the seasonality of its occupation. Comprising basin- and bell-shaped forms, at least one of the identified storage pits contained evidence of having been lined with grass, a technique documented at other Late Woodland sites up and down the Connecticut River and correlated strongly with the storage of cultigens (Bendremer et al. 1991; Lavin 1988; Thomas 1990). Significantly, all of the excavated storage pits contained carbonized maize, beans, and squash. It is inferred that many of these storage pits were subsequently reused as refuse pits. The contents of the refuse pits suggest a diet consisting of both wild and cultivated plant foods and a wide variety of animals including deer, beaver, fox, fish, turtle, bird, and freshwater mussel. Based on this refuse profile, and in consideration of the observed flood deposits that separate the occupational levels, Skitchewaug likely was occupied nearly year-round with a temporary abandonment during the spring to avoid flooding. Similarly, the assemblage suggests that the introduction of agriculture did not cause a complete shift in subsistence strategies. Because of the short growing season in much of Vermont, agriculture may not have had the importance it achieved in southern New England (Thomas and Bourassa 1986).

This intensive occupation of a horticultural camp does not preclude the continuance of seasonal camps. Late Woodland sites located at prime fishing spots along falls have been identified in Vernon and Bellows Falls, while VT-CH-28 and 29, close to the first falls above the Lamoille River, appear to have been chosen for the same reason. Extractive camps, designed to quickly exploit a seasonal resource for processing back at a larger base camp, also continue during this period, especially in the lowlands. VT-FR-161 and VT-FR-140 along the Missisquoi River contained broken Levanna points, hearths, and burned bone suggesting the use of the site as expedient hunting camps, as did the Dewey's Mills Site on the Ottauquechee River. A portage camp dating to this period also has been identified at Warrel Farm on the east bank of the Passumpsic River in East Barnet.

Small residential camps are, in fact, the most common site type identified in Vermont. These camps appear in every type of environmental niche and, while often containing restricted artifact assemblages, likely represent a broad range of functions. Small upland camps containing Levanna points have been interpreted as family hunting camps occupied for several months during the fall and winter to capitalize on hunting and trapping opportunities. Sites of this nature have been identified around Shelburne Pond and Sunderland Brook on the northwestern side of the state, along the Hoosic River floodplain in Pownal and along the Wallomsac River and Jewett Brook in the extreme southwestern corner, and in upland locations along the West River in Jamaica in the south-central portion of Vermont. All were dated by the presence of Levanna projectile points and are assumed to date relatively early in the Late Woodland.

As suggested above, Levanna projectile points remain the "diagnostic" projectile point marker for the Late Woodland and are commonly manufactured from locally available stone. Assemblages tend to be rather restricted and often contain a narrow range of preforms, scrapers, drills, and expedient flake tools. It is possible that rather than using a restricted range of artifact classes, Late Woodland people are instead using a broader range of materials (bone, antler, and wood) with which to fashion an equally broad range of tools. These types of organic materials do not survive well archaeologically and, as such, would produce an assemblage skewed toward lithic materials that may or may not be representative of the assemblage overall.

Unlike the identifiable tool technologies of the period, ceramic traditions shifted rather dramatically beginning about A.D. 1300. At this time, crushed shell began to replace grit as the temper of choice and narrow concoidal forms began to take on a more globular appearance. Vessel rims become increasingly elaborate and are often decorated with incised geometric motifs. Ten Late Woodland vessels were recovered at the Donahue Site (ca. A.D. 1440) and, while grit tempered, provided a cross-section of the types of decorative styles common for the period. The Ewing Site at Shelburne Pond also yielded a large collection of ceramics, many of which were shell tempered and exhibited stylistic affinities with Owasco, proto-Iroquoian and subsequent post-contact period vessels (Petersen 1977, 1992).

Mortuary ceremonialism is markedly less elaborate than in previous periods. Individuals tended to be interred on their sides in a flexed position with few or no grave goods, although some bodies have been reported in a sitting position in the Connecticut Valley. Skitchewaug contained two burials, one a primary inhumation of a 30–50-year-old woman, and the other a secondary interment of an adolescent. Neither burial contained evidence of grave goods (Heckenberger et al. 1992). The Chipman's Point rockshelter, located on a limestone bluff overlooking Lake Champlain, provides a more controversial picture of Late Woodland burial practices. The site contained two interments, one of which, a young girl, had been badly disturbed by pothunters (Haviland and Power 1994). The second body, that of a 45-year-old woman, was identified in three separate deposits at the eastern end of the shelter. The third deposit contained the skull and long bones of the body, the latter of which had been split lengthwise in a fashion mimicking that of a butchered animal carcass. Initial interpretations suggested cannibalism, a well-documented phenomenon among the Iroquois during the post-contact period, but also identified during the Late Woodland. Whether the body was actually cannibalized, who may have done it, and for what reason remains an open question and it stands as the only such burial in Vermont.

Contact Period

European contact in Vermont was initiated in 1609 with the voyage of Samuel de Champlain. Poor relations with the Iroquois discouraged further encroachment to the interior of the region for the next 40 years, but the southern and western proximity of non-Native influences, including French, English, and Dutch, set into motion a series of fundamental changes in Indian lifeways (Duffy and Feeney 2000).

The Western Abenaki, concentrated in the Connecticut River valley, were the dominant native group in Vermont at the time of European contact (Day 1978). Valuable allies to the French in their struggle against the English for dominion in northern New England, the Abenaki waged pitched battles against the Mohawk for control of the lucrative fur trade up and down the Connecticut and St. Lawrence rivers (Haviland and Power 1994). The lines drawn between these two native groups reflected not merely the priority of newly introduced economic interests but the priority of cultural survival in ancient societies decimated by disease and warfare.

Because of their inland location and because of the long shadow cast by their Iroquoian neighbors to the west, little is known about the Vermont Abenaki during the contact period (Day 1978). It is assumed that settlement and subsistence patterns practiced during the Late Woodland Period were carried through, but that subsequent disease and warfare reduced Abenaki numbers and likely precipitated a shift in survival strategies (Day 1978).

One of the major documented shifts in settlement practices during the seventeenth century was the establishment of French Jesuit missions along the Connecticut River in the east and near Lake Champlain and along the St. Lawrence and Hudson rivers to the west. The establishment of these “permanent” Catholic settlements did not preclude the continuance of seasonal rounds among the Native groups that populated them, nor did they guarantee Catholic conversion. They did, however, provide shelter from hostile European and Native groups, food and farming opportunities, and a central meeting place for Abenaki families displaced by war and disease (Calloway 1990). Within Orange County, approximately 20 miles northeast of the Pike Hill Mines Site, the mission at Koes (Coos) in what is now Newbury, was mapped by Father Joseph Aubery ca. 1713, and is described as the “ancien Village des Loups,” the French name for the Western Abenaki (Haden 1959). The Coosuck band of the Abenaki had an agricultural community in this area (Andrews 1964:59). The Coosuck were the primary inhabitants of the county prior to their 1721 defeat in New Hampshire. After 1721 the vast majority of the Coosuck moved to the St. Francis, Quebec region of Canada where they were absorbed by other tribes. Eventually some members of the tribe did return to the region, but their mass departure effectively opened the region for European settlement (Andrews 1964:60).

During the contact period it is probable that the Waits River watershed was utilized as a hunting, fishing, and trapping territory by the Squakheag (Sokokii) or Coassuck communities, which maintained horticultural fields on the Connecticut River bottomlands to the southeast and northeast, respectively (Thomas and Bourassa 1986:28). One possible mustering-ground for such extractive activities is the Old City Falls Site (VT-OR-FS1). This site, located at the falls of Old City Brook in Strafford, is reported as a large Native American campsite, the location of which suggests that it was inhabited during the spring alewive, shad, and salmon runs.

Known and Expected Pre-contact Period Resources: Waits River Drainage

There are no recorded pre-contact period sites recorded within the Pike Hill Mines Site (VDHP site files). The closest evidence of pre-contact period occupations comes from a number of early anecdotal accounts of Native American artifacts being recovered nearby in the Connecticut and Ompompanoosuc River valleys. These accounts include a number of “Indian relics” recovered from the mouth of the Ompompanoosuc River: “arrowheads, ornaments, etc.” found during the construction of the Passumpsic and Connecticut Railroad in 1848, and “a lot of curiously wrought pottery” discovered near the falls of the White River (Ohl and Potter 1992:9). Despite these accounts, however, only three other pre-contact or contact period archaeological sites have been officially recorded in the general vicinity of the Pike Hill and Ely Mine sites. These include: VT-OR-69 (the Manning Site), a Late Archaic Period occupation about 17 miles from the Pike Hill Mine in the town of Strafford; VT-OR-FS1, a contact period site area in Strafford; and VT-OR-34, a Middle Woodland occupation near the Connecticut River in Fairlee (VDHP site files).

VT-OR-69 (the Manning Site) contains a Laurentian tradition component based on the presence of a broken Otter Creek projectile point and a number of bifaces. This site was interpreted to be a seasonal camp, consistent with the seasonal use of the uplands for fall and winter hunting during the Late Archaic Period. VT-OR-FSI is recorded to have been a contact period habitation site located at Old City Falls on a tributary of the Ompompanoosuc River. Here, Native Americans could have gathered fish during the spring spawning runs and hunted during the fall and winter. VT-OR-34 contains Middle Woodland artifact assemblages along with a possible Late Woodland/contact period component.

The high elevation of the Pike Hill Mines Site (1,640–1,965 ft amsl), the steep and rugged terrain, and the secondary nature of the associated water sources likely contributed to the limited and sporadic occupation of the general site area. Local native populations may have only utilized these uplands for seasonal hunting during relatively short periods of time. It is likely that the densest pre-contact period settlements occurred along the Connecticut River while extractive camps predominate on the Waits River (Thomas and Bourassa 1986:34). Consequently, only small, short-term encampments leaving little or no archaeological evidence would be expected in the uplands surrounding the Pike Hill Mines Site.

CHAPTER FIVE

HISTORIC CONTEXT

This chapter presents a historical overview of the successive mining campaigns at Pike Hill in Corinth, Orange County, Vermont. Additional information about Appalachian sulfide ore bodies, early U.S. and New England copper mining, and the Elizabeth Mine and Ely mines can be found in *Historical Context and Preliminary Resource Evaluation of the Elizabeth Mine, South Strafford, VT* (PAL 2000), *Historic/Archaeological Mapping and Testing, Elizabeth Mine Site* (Cherau et al. 2003), and *Historic/Archaeological Mapping and Testing, Ely Mine* (Cherau et al. 2005).

The name Pike Hill is the geographic name associated with the site. The two major orebodies were closely spaced just north of the Pike Hill summit and the associated mining operations were known as the "Eureka" and "Union" mines. A smaller mine on the south slope of Pike Hill is commonly called the "Smith" mine. The history of these mines is a complex one of several "boom-and-bust" cycles of opening and closure, changing and often overlapping mining company incorporators and operators, and associated name changes. Although the Eureka and Union mining sites appear to be one large site, the combination of the complicated geology, history, and mining activity has resulted in a complex group of distinct mining features superimposed on the Pike Hill landscape.

The Pike Hill Mines Site is situated in the east-central part of the town of Corinth. The village of East Corinth is the closest civic/institutional/commercial/residential node to Pike Hill, which has historically been peripheral to the town's settlement centers. The mine played an important role in the town's economic prosperity in the second half of the nineteenth century. The cultural chronology of Corinth and its environs is therefore included at the beginning of the chapter. It provides the non-mining historical context for the project study area from the earliest period of Euro-American settlement to present-day.

Historical Development of Corinth

1700s to 1824

The town of Corinth is located in the approximate center of Orange County, about 10 miles west of the Connecticut River, 40 miles north of Windsor, and 20 miles southeast of Montpelier. It is bounded on the north by Topsham, on the east by Bradford, on the south by Vershire, and on the west by Washington. The town is 6 miles square in size, and was chartered by Governor Benning Wentworth of the Province of New Hampshire in 1764 to Col. John Taplin, Maj. Henry Moore, and a Mr. Ward (Hemenway 1871). A few families moved into the area from New Hampshire and Massachusetts over the next several decades, but the town was not formally organized until 1780. In that year a town clerk was appointed to oversee the administrative matters of the few dozen inhabitants. Shortly after a small fort was built near the center of the town on Cooke's Hill, and two companies of soldiers were sent to protect the inhabitants from Indian hostilities.

Also in 1780 the town's first gristmill was erected by John Aiken of Wentworth, New Hampshire. It was located on the Waits River near East Corinth. Prior to that time the inhabitants had to travel 12 miles to

Newbury to grind their corn and other grains. Later that same year Simon Johnson, a native of Massachusetts, established the town's first grist and saw-mill (Child 1888). Throughout this period the early settlers were primarily occupied by agricultural activities. Every 100-acre lot granted in the town was said to be capable of being cultivated as a farm and homestead (Hemenway 1871). Some of the early settlers were also involved in manufacturing maple sugar (Child 1888; Hemenway 1871).

1824 to 1850

In 1824 the town boasted 10 blacksmiths, three distilleries, four tanneries, five clothing works, six gristmills, and eight sawmills. In the 1830s and 1840s the town's villages and named hamlets were more firmly established. Villages included Corinth Center, Corinth Corners, East Corinth, South Corinth, West Corinth, Goose Green, and Cookeville. The town's first post office was established at Cookeville in 1806. The village took its name from Daniel Cooke, who came to Corinth about 1787 from Newton, Massachusetts. Cooke ran the general store, which included a potash plant, a tannery, a gristmill, and a distillery. He also practiced cattle trading and kept a hotel in his home, which stood in the village center (Swift 1977). The town's second post office was established at East Corinth Village in 1833. East Corinth was also called Taplin Mills or Taplin Village, after Col. John Taplin, one of the original proprietors. Taplin erected a gristmill, sawmill, fulling mill, mill to extract seeds from clover, a starch factory, and a distillery in the village (Swift 1977). By the 1850s Corinth had reached its peak of 1,970 residents.

The Pike Hill area is situated outside of the village centers, between East Corinth, West Corinth, and Corinth Center. It was originally settled by Daniel Pike as a large farm property in the early 1800s (Swift 1977). After his death about 1849 his widow, Sarah, sold 60 acres of the farmland to Lyman M. Thayer. Thayer in turn sold this land to Silas Goddard of Worcester, Massachusetts. Local farmers including Ford, Towle, Luther, Smith, Sanborn, Bond, Banks, and Woodcock later bought other portions of the Pike farm. These farmers allowed outside interests to prospect for copper ore on their lands (Anon. 1964). The lands became known collectively as "Pike Hill."

1850 to 1880

The 1858 map of Corinth depicts the villages of Corinth Center, East Corinth, and West Corinth along with a well developed road network that connected the village centers to each other as well as to centers in Bradford, Topsham, Vershire, and Washington (Figure 5-1). The Pike Hill area is clearly void of habitation although Richardson Road appears along the north side of the hill and was the site of several farm/homesteads including that of S. Richardson. No settlement or other improvements are shown within the project study area at that time. However, the hill had been the site of copper ore prospecting by Isaac Barbour of Oxford, MA who made several excavations on the bed and obtained ore from the surface (Abbott GMC 1964:5–6).

In the 1860s and 1870s the town continued to develop its village centers and fill in with scattered farms along the main roads leading to and from the villages. The town was primarily agricultural throughout the period. Local farmers were heavily engaged in sheep farming and the processing of wool. Dairy farming was also prominent. Cheese, then butter, then fluid milk were exported to urban markets through

Figure 5-1. 1858 map of Orange County, Vermont, showing the approximate location of the Pike Hill Mines Site (source: Walling 1858).

railroad shipping. Creameries were established in Goose Green and East Corinth. Lumbering was also a big business that provided work for loggers and farmers all year long. Sawmills were erected on nearly every stream of any size that could be dammed for water power (Anon. 1964). By 1877 there were 20 school districts within the town boundaries including those of the original seven village centers (Figure 5-2).

The Pike Hill area was located in the southern part of District No. 5 and the northeast part of the Cookeville District located north of Corinth Center. The "Corinth Copper Company" and "Union Copper Company" worked the copper ore mines intermittently during the 1860s to about 1880. This activity included establishment of a small village near Richardson Road, just north of the mines. The village housed most of the mines' workers, who were of mixed nationalities including Irish, English, French, Dutch, and German (Blaisdell 1982). Worker housing was arranged in three distinct rows set into the north facing hillside in proximity to the road (Figures 5-3, 5-4, and 5-5). The "upper row" of worker housing consisted of a series of double tenement houses; the "lower row" was all single houses. Each area had its own row of outhouses. The New Row was a later development, and consisted of one long building, divided into separate smaller tenements accessed directly from outside (Blaisdell 1982). The ca. 1880 photographs also depict several barns and outbuildings associated with the housing. There was also a general store run by an Englishman named Standlick (see Figure 5-5), and a schoolhouse with a belfry and a large bell (Blaisdell 1982). At the peak of the mine's prosperity there were as many as 100 pupils in the mine village school. Many farmers took jobs hauling ore to the Passumpsic Railroad depot in Bradford, approximately 13 miles away. The mines provided a ready market for area farmers to sell their meat and produce (Farnham 1872:261–262; Swift 1977).

Other industries established in Corinth during the second half of the nineteenth century included two carriage shops in East Corinth. These shops made buggies and sleighs for sale throughout the region. Local manufacturers also included Joel Barnes & Sons of Goose Green who produced linen shoe thread sought by shoemakers both in and out of state. Cordage was added to their products when both flax and hemp were raised by local farmers. This industry employed many local residents from about 1845 to 1880 when it went out of business (Anon. 1964).

1880 to 1950

In 1880 the town of Corinth had a population of 1,627 inhabitants, divided among 15 school districts (Child 1888). The village of West Corinth contained one store, a grist and sawmill, one church, and about a dozen dwellings. The Waits River passes through the village of East Corinth, providing ample waterpower for grist and sawmills, a bobbin factory, and several shops. The village center contained about 30 dwellings, a church, graded school, several stores, a hotel, stage lines to various points, and a telephone. Corinth Center contained a Congregational Church and one-half dozen farmhouses along with a general store. Corinth Corners in the southwest part of the town contained one church, a schoolhouse, a sawmill and a dozen dwellings (Child 1888).

In 1882 the mining operations at Pike Hill closed and the town went into a severe local depression. A road that had been built by the town to connect the mine at Pike Hill and Cookeville, a distance of about 3.5 miles, had so little travel after the mine closed that it reverted to woodland (Anon. 1964). Many of the older farmers died in the last decades of the nineteenth century, and their estates were divided among heirs living out of state. The heirs sold the surrounding farms, and the miners and their families moved away, leaving a large void in the local economy (Anon. 1964).

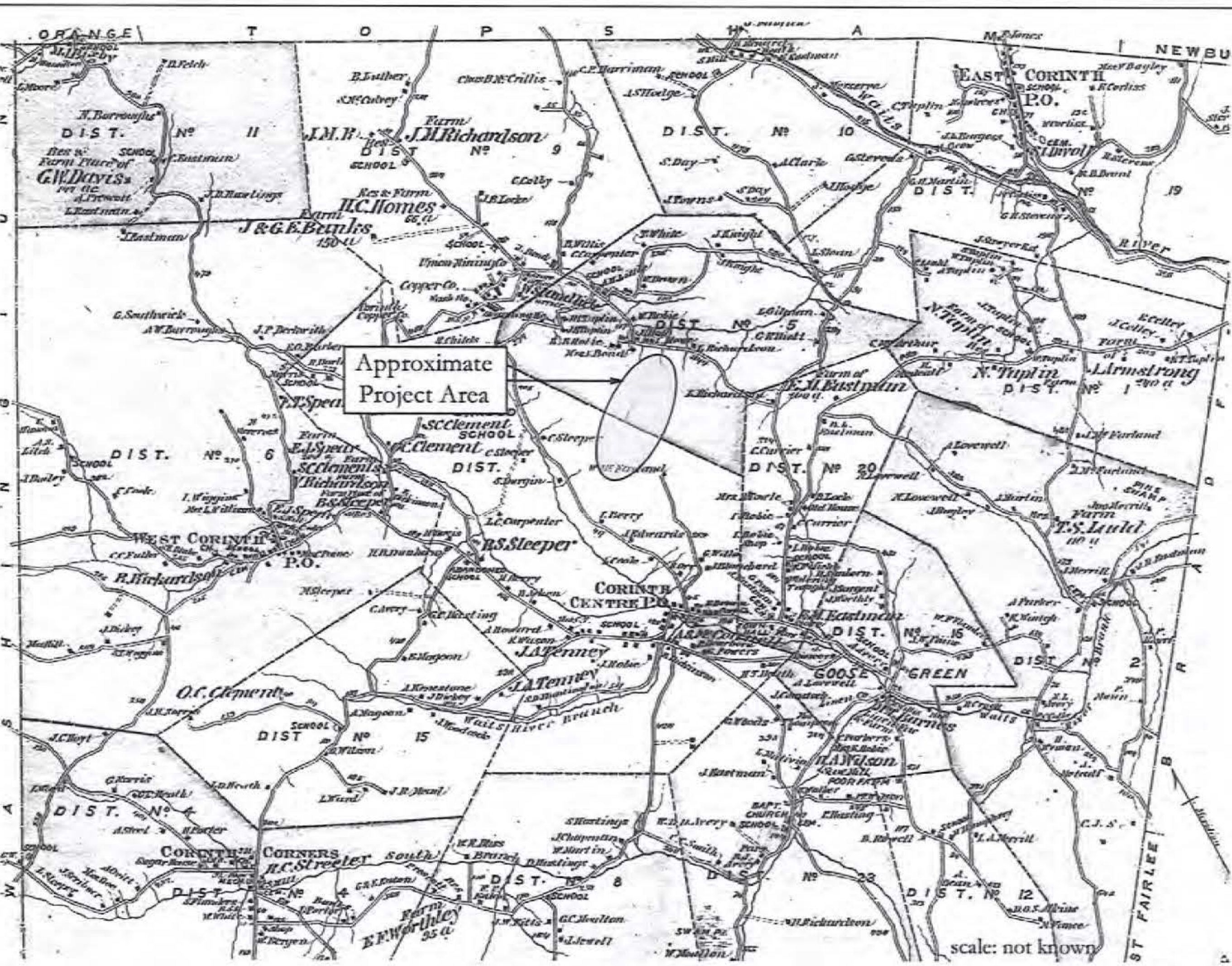

Figure 5-2. 1877 map of Corinth, Vermont, showing the approximate location of the Pike Hill Mines Site (source: Beers 1877).

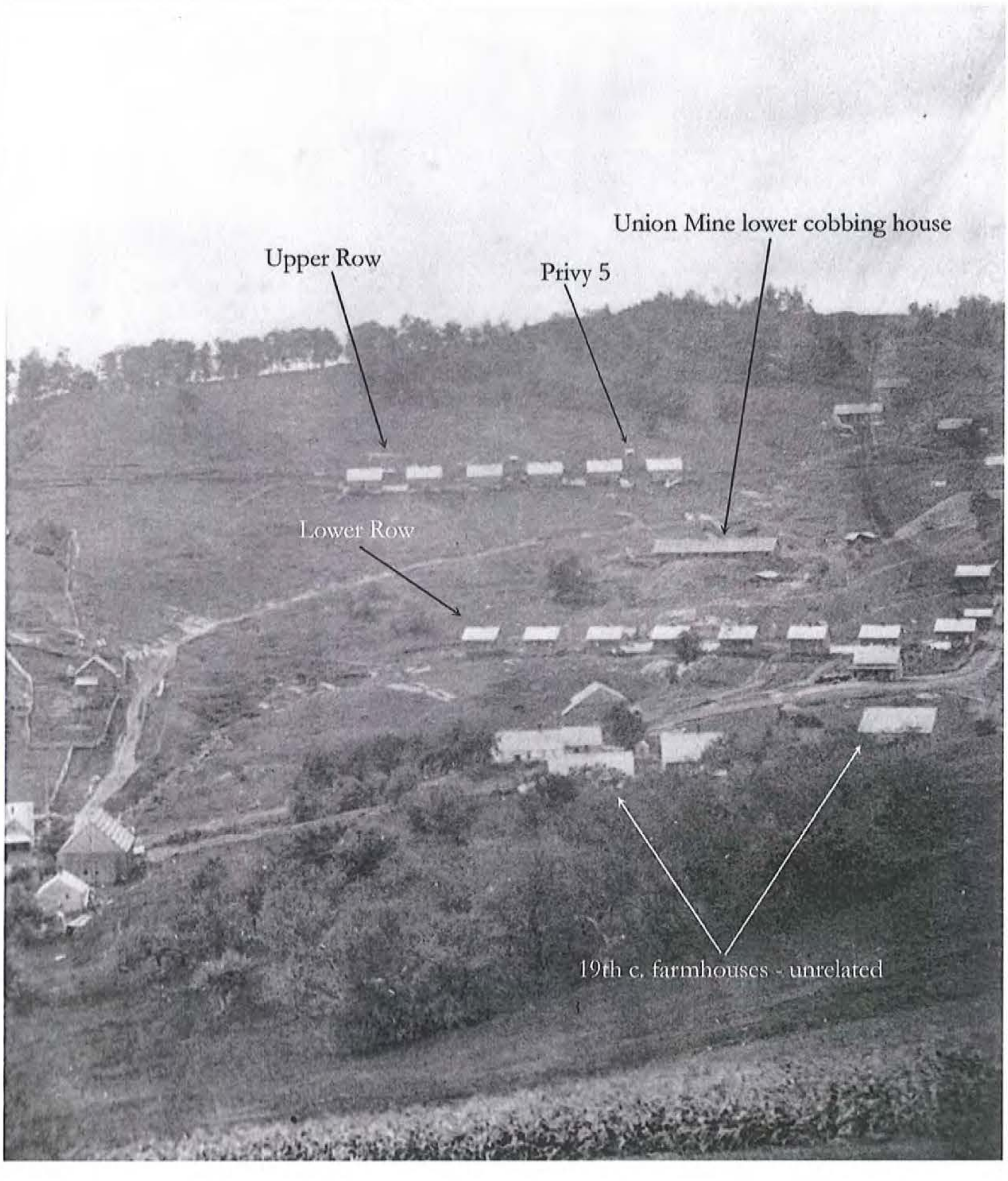

Figure 5-3. Ca. 1880 photograph of the Union Copper Mining Co. village area, showing panorama view of northeast slope of Pike Hill, looking east (source: http://www.uvm.edu/landscape//).

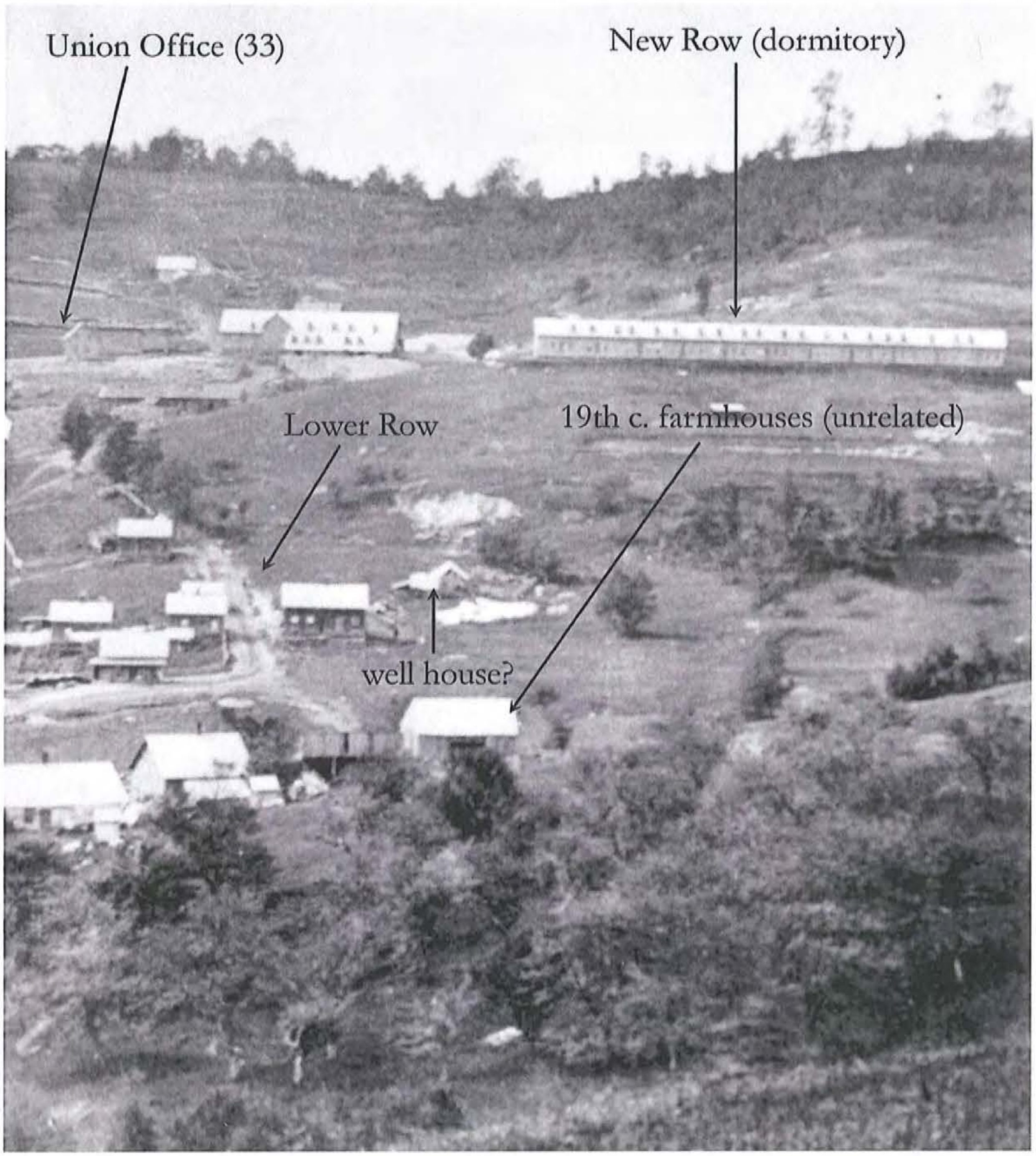

Figure 5-4. Ca. 1880 photograph of the Union Copper Mining village area, showing New Row (dormitory) in the background and Lower Row housing in the foreground closest to Richardson Road, looking east (source: http://www.uvm.edu/landscape//).

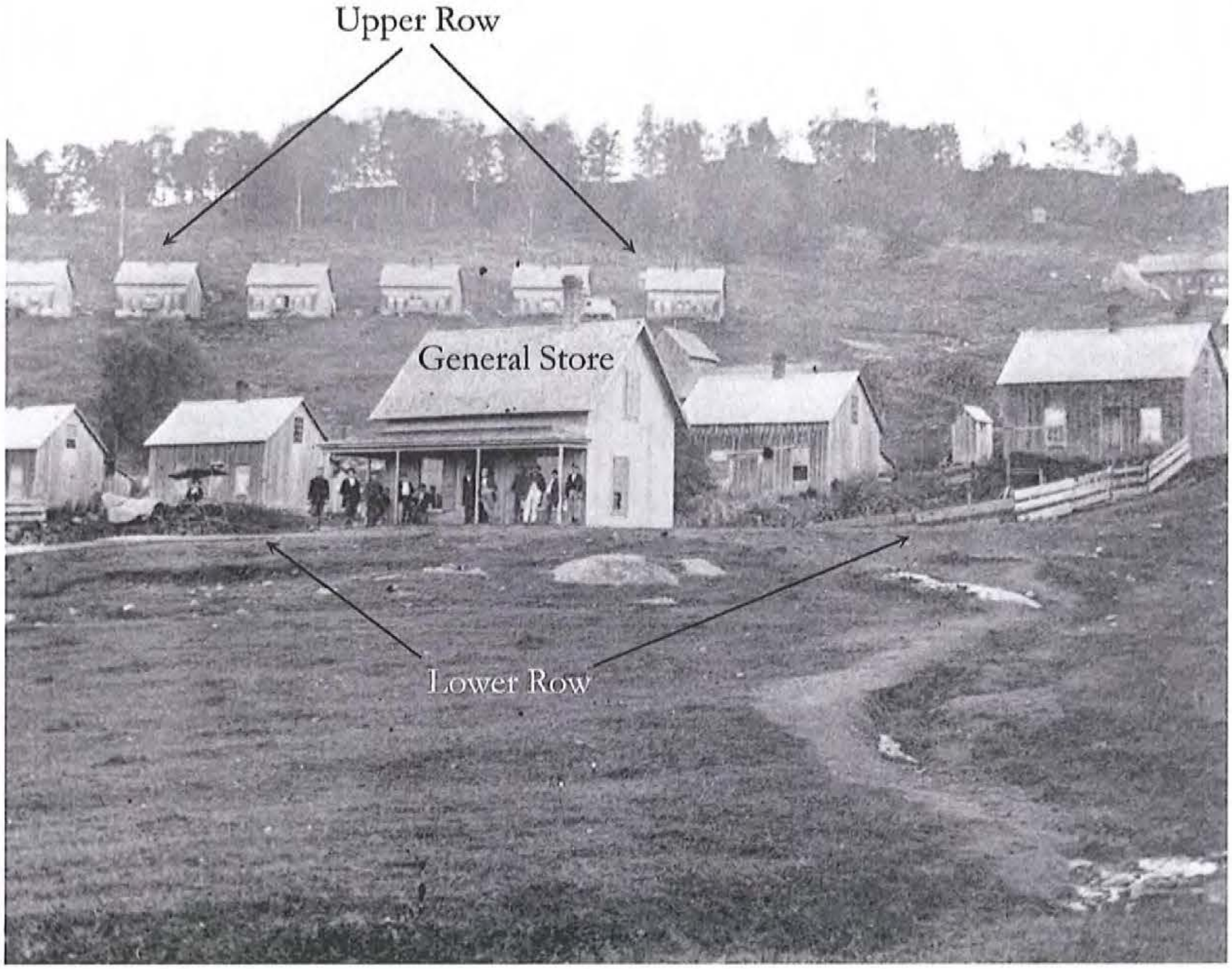

Figure 5-5. Ca. 1880 photograph of the Union Copper Mining village area, showing closeup of Lower Row housing and Upper Row in the background, looking east (source: http://www.uvm.edu/landscape//).

housing was built to accompany the new mill and office. The mines were closed until World War I when they resumed operations in 1915, and then closed for the last time in 1919 (Abbott 1964: 306–307; Anon. 1964; Blaisdell 1982). Early twentieth century photographs of the mine site show the general store near Richardson Road, and an old farmhouse nearly opposite (Figure 5-6). All of the mine village housing (upper row, lower row, new row) and associated barns, privies, and other outbuildings had been removed by that time. The schoolhouse was also sold and moved (Blaisdell 1982).

1950 to Present

The local economy and demographics of the town remained relatively unchanged in the first half of the twentieth century. Dairy farming continued to provide an economic mainstay along with lumbering. The development of the interstate highway system in the 1950s and 1960s resulted in some changes to the rural complexion of the town. Its rural character has been retained, but marginal farmlands have increasingly been sold and subdivided for primary and secondary residential homes. Open land is also gradually being replaced with brushland and reforestation. Agriculture has also declined considerably over the past several decades. In 1983 the town had 15 working farms with some of the best herds of cattle in the state. In 1991 there were 11 full-time farms remaining and in 2000 there were only seven active farms, two of which produced high quality cheeses (Anon. 2007).

Today, there are a number of local residents participating in part-time farming activities that include hay sales, poultry farming, beeswax and honey production, and raising sheep, goats, and replacement heifers. The Corinth maple industry has also expanded in recent years, with several majority producers and many small family sugar houses. A growing part of the local economy is found in home-based businesses involved in internet sales, commercial knitting, software design, and business consulting. Currently, Corinth has two convenience stores, three auto repair shops, a small engine repair shop, and a body shop.

Four of the historic villages (East Corinth, Goose Green, South Corinth, and Cookeville) currently serve as identifiable areas within the town. Some, like East Corinth, contain a mix of land uses, while others such as Corinth Corners are primarily residential/agricultural in nature. Residents living outside the village areas are scattered along the approximately 94 miles of town roads and highways, and along the 4 miles of Vermont Route 25. The majority of the town’s 31,000 total acres remains undeveloped forest land and pasture (Anon. 2007).

Historical Development of the Pike Hill Mines

Early American Copper Mining

The first American settlers prospected for minerals for the manufacture of metal goods and to raise capital. During the seventeenth and eighteenth centuries finished copper goods were imported from Europe. Most of the copper ore encountered in the colonies was of the sulfide (pyrite) variety, which was particularly difficult to smelt. Large sulfide copper orebodies remained unexploited until the early nineteenth century, when these ores were shipped to Swansea, Wales, where the sulfide ore smelting process had been perfected. The earliest and most productive colonial copper mine in New England was started in Simsbury, Connecticut. In Maryland, the Liberty Mine was the most productive American copper mine to have operated during the Revolutionary War (Young 1983:117–125).

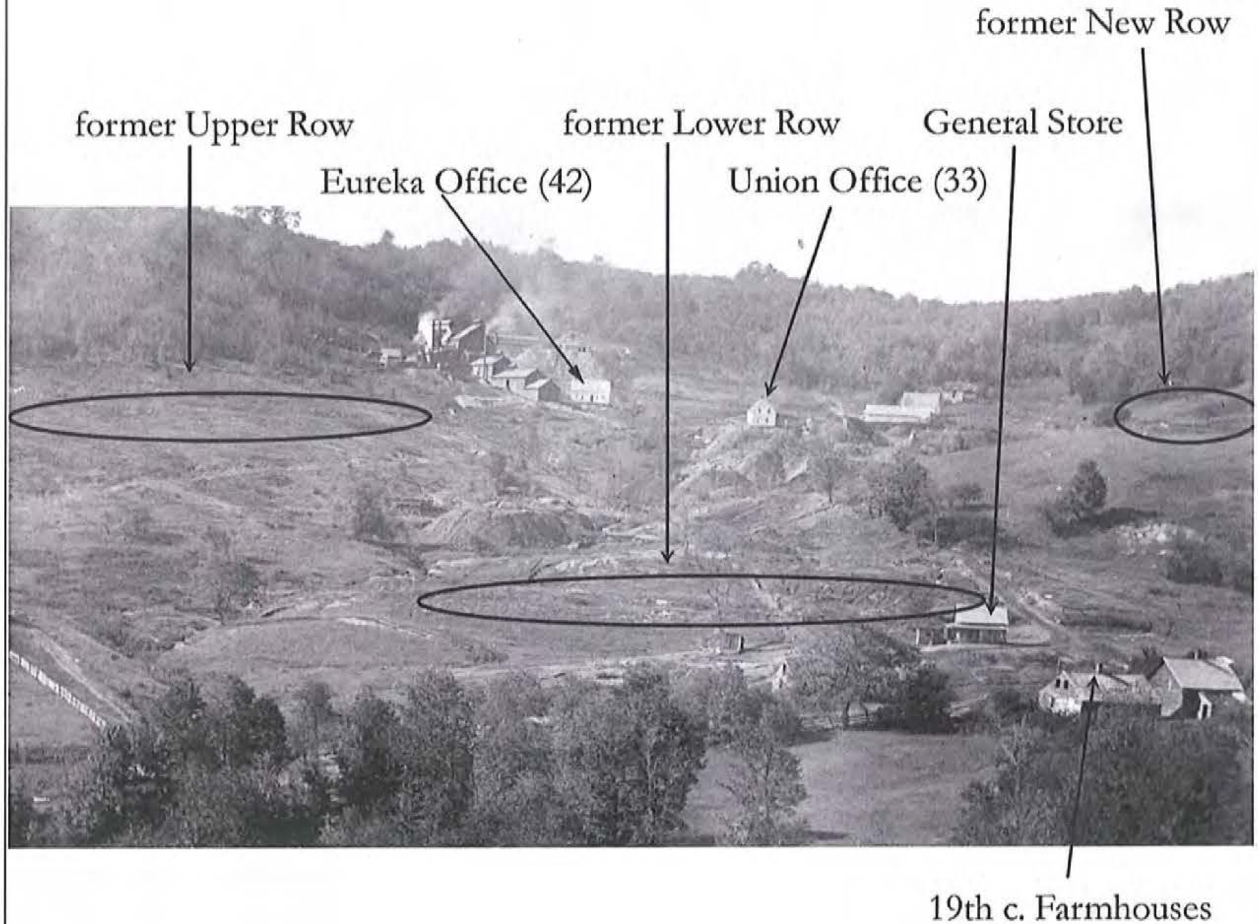

Figure 5-6. Ca. 1907 photograph of the Pike Hill Mines Co., showing former locations of miner housing areas, looking east (source: http://www.uvm.edu/landscape//).

The colonial copper industry suffered because of unfavorable economic systems, a lack of skilled labor, and poor transportation. Post-Revolutionary War conflicts and trade restrictions disrupted copper imports, and there was no domestic copper mining or smelting industry to satisfy the demand. By the 1840s, however, protective tariffs were in place, skilled miners and smelter men could be recruited, and railroads and canals had penetrated the interior. Copper smelters were opened at Boston, Baltimore, and New Jersey, and smelted Appalachian sulfide ores to supplement imports of ores from sources such as Chile and Cuba (Abbott: 1971:426; Young 1983:126–132). The Civil War provided a boost to northern mines such as the Ely Mine in Vershire. However, by the 1880s, Michigan and new mines in Montana and Arizona eclipsed Appalachian copper.

Copper was mined in the Eastern U.S. for at least 275 years. Between 1760 and 1844, when the domestic smelting industry began, eastern production was roughly 3,000 tons. The region's production from 1844 to 1962 was about 965,000 tons, about two percent of U.S. production for the period. Ultimately copper production in the east was minuscule compared to the output of the U.S. and even some individual U.S. mines. Although the large operations of the American West have dominated U.S. copper production since the early twentieth century, several eastern U.S. copper mines were reopened and worked profitably at times when wartime demand warranted it or prices were high enough, and they could be operated efficiently with proven technology. Several Appalachian sulfide mines, including the Pike Hill mines at Corinth, did not experience significant productivity until the application of modern mass production technology in the early twentieth century (Abbott 1966:79–80).

Vermont Copper Belt Introduction

The Pike Hill Mines Site (VT-OR-27), which includes the Eureka, Union and Smith mines, is one of three major copper mining sites that operated in the 20-mile-long Orange County, VT, "Copper Belt" during the nineteenth and twentieth centuries. The Pike Hill mines ranked third in output compared to the Ely and Elizabeth mines to the south. Pike Hill was the scene of intermittent copper mining from 1846 to 1919, with its greatest periods of production between 1878 and 1881 when it supplied ore to the smelter at Ely, and again during World War I, when a modern flotation mill was operated. Although the Pike Hill mines operated sporadically and were overshadowed by the Ely Mine and the Elizabeth Mine, they contributed an estimated 1/17th of the copper produced in the Orange County Copper Belt. The total copper production of the Pike Hill mines is estimated at 8,600,000 lbs. There was no smelting at Pike Hill; ore mined there was taken to Ely and East Coast smelters to be refined. One significant technological achievement within the "Copper Belt" was magnetic separation of the unwanted iron sulfide mineral pyrrhotite from the copper-bearing chalcopyrite in the milled ore. This process, which failed at the Elizabeth Mine, was used successfully at Pike Hill in 1906 and 1907.

The Elizabeth Mine (VT-OR-28) operated almost continuously from 1809 to 1958. Of the three Vermont Copper Belt mines, it produced the highest tonnage of copper, and left the largest and most complex mining landscape. Mining began in 1809 for the production of copperas, or iron sulfate, an important industrial chemical. This operation eventually became a major domestic source of copperas until it closed in the early 1880s. President James Monroe visited the copperas works on the site of the future Elizabeth Mine in 1817 as part of a goodwill tour of area industries affected by changing trade regulations. Copper was smelted beginning about 1830 and in eight brief subsequent campaigns until 1919. The mine was revived for World War II and closed in 1958. The mine was the scene of several important firsts in American copper metallurgy, including successful mineside smelting, large-scale smelting of sulfide ores, smelting with hot blast and anthracite, and successful use of chromite refractories. Elizabeth Mine probably had a total lifetime output of more than 100,000,000 lbs of copper.

During the nineteenth century, the Ely Mine (VT-OR-14) outstripped copper production at the Elizabeth Mine in South Strafford and ranked among the top 10 copper producing mines in the United States. The Ely Mine often contributed more than 2 million lbs of pig copper, and sometimes more than 3 million, to annual U.S. output during the 1870s and was still productive into the 1890s. It was the third-largest-producing U.S. copper mine in 1873 and 1875, and ranked fourth through ninth in the rest of that decade. The Ely Mine included a large copper smelter, erected in 1867 and ultimately reaching nearly 1,000 ft in length. The mine fostered the growth of a substantial workers' village that influenced the local economy. The mine was the scene of labor unrest that resulted in the "Ely War." After its major period of production in the 1880s, it was the victim of fluctuating copper prices and unsmanagement. Under Frederic Cazin and George Westinghouse, the mine was the site of several late-nineteenth- and early-twentieth-century efforts aimed at efficient extraction of copper from low-grade ores and mine wastes and new smelting furnace technology. Ely Mine was the only copper mine in Vermont where all technological aspects of refined pig copper production, from mining of raw ore to smelting of refined copper, were successfully integrated on a large scale. The mine's overall production stands somewhere between 30 and 40 million lbs of copper.

Lack of complete and consistent nineteenth-century records makes accurate estimation of Vermont's total copper output difficult. Based on conservative analysis of existing records it appears certain that Vermont was the second-largest copper-producing state for at least part of the 1870s. The major producers in order of production during the 1860s and 1870s were Michigan, Vermont, and Tennessee. Vermont was far behind Michigan, which produced more than 60 percent of domestic copper from 1854 to 1882. The 1880 census placed Vermont, with 2,647,894 lbs of copper, in third place behind Michigan's 40,389,212 lbs, and Arizona's 3,183,750 lbs. By 1882 the western mines began to pull ahead, and Vermont ceased to be a major contributor to U.S. copper production. Industrial production figures for the mid-twentieth century are more accurate. In 1953 the Elizabeth Mine was the nineteenth highest producing copper mine in the U.S. Between 1946 and 1956 it was among the top 25 producers and was twentieth in five of those years. In 1950 there were 300 copper mines in the country. The top five produced 67 percent of U.S. copper and the top 10 produced 85 percent. Total copper output for the Orange County Copper mines between 1793 and 1958 has been estimated at about 145 million lbs, with about 100 million from the Elizabeth Mine, about 35 million lbs. from Ely, and less than 10 million from Pike Hill (Abbott 1964:144, 336–338, 444–448; Howard 1969).

Mine Discovery and Early Aboveground Operations, 1845–1863

The following section follows the history of the three mines at Pike Hill: the Union and Eureka mines, and the much smaller Smith mine. It is significant to note that there is far less primary written information for the Pike Hill mines than their much larger counterparts in Vershire and South Strafford, and virtually no cartographic documentation. The number, dimensions and configuration of Pike Hill mine shafts and adits (horizontal access tunnels) appearing in geological reports can appear confusing and contradictory. As noted above, the history of the Pike Hill mines is one of several "boom-and-bust" cycles of opening and closure, changing and overlapping mining companies and owners, and mine name changes. The corporate history adds a layer of complexity to the story, and is somewhat abbreviated here for clarity. For additional corporate history details, the reader is directed to Collamer Abbott's unpublished manuscript on the Vermont copper mines (Abbott 1964). The narrative in this chapter focuses more on the chronology and nature of mining and beneficiation operations to provide the background for the following chapters on significant industrial processes (Chapter 6) and the physical description and interpretation of the mining landscape and remains (Chapter 7).

The Pike Hill ore deposits were discovered after the deposit in South Strafford and Vershire. One story alleges that fox hunters searching for a lost dog found it trapped under a ledge that outcropped in the oxidized earth over the ore. The ore was probably found by Ira Towle in 1845 on his land south of the summit of Pike Hill, and on land to the north within the former farm of Daniel Pike. The Second Annual Vermont state geological report by C.B. Adams noted the discovery of rich copper ore in Corinth:

> A rich vein of copper pyrites, occurs in this town, two and one half miles west of the village. Not improbably it is a part of the great vein of pyrites which is worked in Strafford. The vein here is twenty feet wide, and the copper pyrites is mostly in a portion eighteen inches wide. . . . The ore appears to be rich, and is worth of attention (Adams 1846:226).

This first Pike Hill discovery appears to have been made at the small deposit at the southern extremity of the ore exposures on the hill, at the site of what later became known as the Smith Mine. In 1846, Towle and landowner Samuel C. Clement leased the mineral rights to Isaac R. Barbour of Oxford, MA. Barbour and partner Charles Allen dug some ore and sent it to the Revere Copper Works smelter at Point Shirley in Boston, but the mine was not profitable. Barbour opened a series of shallow exploratory pits dug to bedrock for 3,300 ft along the strike of the ore bed, up the south side of the hill to its summit, where he stopped just short of the major part of the deposit that began at the top of the hill (Abbott *GMC* 1964:5–6, 46, 289; Whitney 1854:314). These pits, or mid-twentieth-century exploration trenches superimposed on them, are still visible today.

In December 1853 Silas Goddard of Worcester, Massachusetts purchased another portion of the former Daniel Pike farm land at the summit of Pike Hill, north of Barbour's prospects on the south slope. Goddard then sold the property to two New York men, Charles M. Wheatley, and Joseph Bicknell, who was one of the original incorporators of the Vermont Copper Mining Company at the Ely Mine. Wheatley was a practical mining engineer, and had been superintendent of the Bristol, CT copper mine as well as the Perkiomen and others in Pennsylvania. By early 1854, Goddard, Bicknell, and J. Elnathan Smith, another New Yorker and Ely Mine investor, had formed a company and acquired two additional tracts of land. This enterprise dug the ore by hand from an open cut during the part of the year when the ground was not frozen. This activity likely took place at the location of the large open cut that extends north from the summit of Pike Hill. The name "Cuprum" (Latin for copper), which is associated with early operations at this mine opening, may date from as early as this period. This mine was later associated with the name "Eureka." By June of the same year the company reported that it had mined 200 tons of ore containing between 16 and 20 percent copper. This was likely the grade of the shipped ore, which was "cobbed," or broken with hammers and hand sorted to raise its average copper content. In 1855 the company experienced financial difficulties, and the property was split and deeded to pay creditors. In November of the same year the company reorganized as the Corinth Copper Company with William Cornwell, another incorporator who had interests in the Ely Mine. Joseph Bicknell was able to buy up the split mine properties and deed them back to the Corinth Copper Co. in April 1856. Surface mining activity had proved the richness and extent of the deposit, but had exhausted all the ore safely available, and the company ceased activity (Abbott *GMC* 1964:290; Jacobs 1944:11–12).

Other copper mining companies were forming and acquiring land on Pike Hill at this time. In August 1854 Henry Barnard purchased 60 acres of Daniel Pike estate land north of the Corinth Copper Company. He sold part of his interest to William Cornwell, and, with several other investors in the Ely Mine at Vershire, incorporated as the Eureka Mining Company in 1855. The name Eureka (Latin for "I have found it!") was eventually to become associated with the Corinth Copper Company property to the south when the latter company reorganized with the former's name in 1875, and the 1855 Eureka Mining Company property eventually became the Union Mining Company's land. Additionally, Henry Barnard, Joseph Bicknell, and J. Elnathan Smith formed the Barnard Copper Company, acquiring the land even farther south on the south side of Pike Hill where Isaac Barbour had made his first excavations, at what eventually became known as the "Smith" Mine (Abbott *GMC* 1964:291).

The Hitchcock 1861 geological survey of Vermont noted that Cornish mining captain Thomas Pollard, superintendent of the Ely Mine, felt that the Pike Hill deposit had potential value. The Hitchcocks, however, rightly stated that ". . . experience has established the fact that the only way to work copper lodes with profit, is to sink shafts and drive horizontal adits, and when sufficient capital is invested and judiciously applied by men of experience and good judgment, there is little doubt that the Corinth mines will prove very valuable" (Hitchcock et al.1861:852–853). Indeed, mining activity did not resume on Pike Hill until Civil War copper prices supported renewed efforts.

Civil War Boom

Mining activity resumed in earnest on Pike Hill during the Civil War, when the price of copper rose as high as 55 cents a pound, and underground work commenced with Cornish miners who had come to Vermont with the Vershire copper boom. By the mid-nineteenth century the rich copper, tin, and lead mines of Cornwall, England, were becoming exhausted and Cornish miners were emigrating in search of work. Cornish miners were sought out by American mining entrepreneurs and hired as mining "captains," as they were called, to open and work new mines. The Cornish brought their experience to the Vermont Copper Belt, and many other mines in New England and the United States. Many Cornish miners understood the geology and structure of the Appalachian sulfide deposits and were able to confidently locate the intermittent lenses of ore that characterized these orebodies. The presence of these Cornishmen in key operational positions ultimately contributed to the efficiency and profitability of the Orange County copper mines (Abbott 1970, 1973).

For clarity, the history of the two major mines, the Union Mining Company, and the Corinth Copper Company (later Eureka Mine Company), are separated below into two sections. The properties were eventually briefly united under the Pike Hill Mines Company for the last mining campaign on Pike Hill, 1916–1919.

Union Copper Mining Company

Mining activity resumed at Pike Hill in 1863 with the commencement of underground operations in 1863. That year the Union Copper Mining Company was chartered to work the area acquired by Henry Barnard in 1854, north of the Corinth Copper Company's workings. This company included Smith Ely of the Ely Mine in Vershire as an incorporator (Abbott *GMC* 1964:289-292). The Union Mine produced 5,000 tons of ore averaging 8 to 10 percent copper between 1865 and 1868. In 1868, the mine employed 35 men and was producing 1,600 to 1,800 tons of ore annually About $125,000 worth of the ore was sold to the Baltimore Copper Smelting Co. in that time period. The cost to ship the ore to Portsmouth, New Hampshire or New Haven, Connecticut was $4 a ton. By 1868 ore had been removed from an area 130 ft long, 120 ft high, and 9 ft wide. The company reportedly worked the mine from two short adits on the ore bed and planned a 665-ft long adit to develop more ore (Abbott *GMC* 1964:293). The shorter of these two adits may have been opened up into a 100 ft long haulage cut visible today, and the other, approximately 200 ft long main adit is now partially collapsed. It appears unlikely that the 665 ft long deep adit was ever developed, due to lack of surface evidence, and water being retained in the mine today to the upper adit level.

After the Civil War, the U.S. economy suffered a recession and copper prices fell. In 1869 the U.S. government imposed a tariff on imported copper ores, which hurt the coastal smelting plants that were processing Appalachian sulfide copper ores. Despite these unfavorable conditions, the Union Mine continued to operate. In 1869 the Union Mine employed 60 men and produced roughly 125 tons of 9 percent copper ore per month. The surface plant reportedly included 11 dwellings, a dressing house, a blacksmith shop, ore sheds, office, and other support buildings. The ore was mined underground for 150 ft along its strike via a 300-ft adit and a 200-ft shaft. In 1872 the ore deposit pinched out, and production ceased as three or four men searched for, and then located, a new, lower lens of ore. The Union Mine survived the Panic of 1873 and shipped ore averaging 9.5 percent copper to Baltimore in 1874, 1875, and 1876. In June 1875 the mine employed 70 men, and the following year produced an average of 175 tons of ore per month. The Union Mine finally went bankrupt in 1877 under the lingering weight of the economic depression (Abbott *GMC* 1964:294–297; Farnham 1872:623).

On November 1, 1878, the bankrupt Union Mine property was purchased by Smith Ely, and in August 1879, it was transferred to the Vermont Copper Mining Company, which owned the much larger Ely Mine and smelter at Vershire. The Vermont Copper Mining Company had originally been incorporated to work the Ely deposit. In 1864 Smith Ely, a mine stockholder and wealthy New York furniture dealer, was elected president of the Vermont Copper Mining Company. During the first 14 years of operation under the Vermont Copper Mining Company, the copper ore mined at Vershire was shipped elsewhere to be smelted. In 1867, the Vermont Copper Mining Company had invested heavily in the future of their operation by constructing the first section of what eventually became a massive smelter plant (Cherau et al. 2005:55–66).

The Vermont Copper Mining Company temporarily renamed the Union Mine the “Goddard” mine after Smith Ely’s flamboyant grandson, Ely Ely-Goddard. Several Cornishmen were hired to run the mine. Thomas Chase became superintendent, and Captain John Pascoe, brother of Ely Mine foreman Thomas Pascoe, became mine foreman. Harry Holmes, another Ely worker, was made cobbing house boss. The Vermont Copper Mining Company pursued mining vigorously, and pressure was exerted on the town of Corinth to build a section of road from Pike Hill to Cookeville to provide a road for hauling the ore to the Ely smelter 9 miles away. The road was completed in 1880, and 60 teams of horses pulled the carts of ore to the smelter. The Pike Hill ore contained additional silica that was helpful as a smelting flux, which saved costs at the Ely smelter. The added volume of the Pike Hill ore required an increase in smelting capacity, and in 1879 Smith Ely added another 200 ft to the Ely smelter building and installed new furnaces, bringing the final total to 24 (Abbott *GMC* 1964:297; Blaisdell 1982:70–71; Child 1888:25).

Additional buildings were constructed at Pike Hill, including the “New Row,” a single 265 ft long building consisting of 11 attached tenements, which was built north of the Union Mine workings. The mine landscape was first documented in a series of photographs at this time (see Figures 5-3, 5-4, and 5-5, also Figures 5-7, 5-8, and 5-9). William Standlick and Spaulding Locke reopened their store. About 125 men worked at the mine. The mine included a new blacksmith shop, washhouse, and a weigh house with a new set of large ore weighing scales. In May 1879, a new washhouse was built and the ore processing plant was enlarged to accommodate new jigging machines for separating fine ore and waste rock. In October, the washhouse burned, putting almost 150 men out of work. It was quickly rebuilt. In 1879 and 1880, the mine shipped 5,712,604 lbs of “fines” averaging of 2.7 to 4.5 percent copper to the Ely Smelter (Abbott *GMC* 1964: 297–299; Weed 1904, 1911).

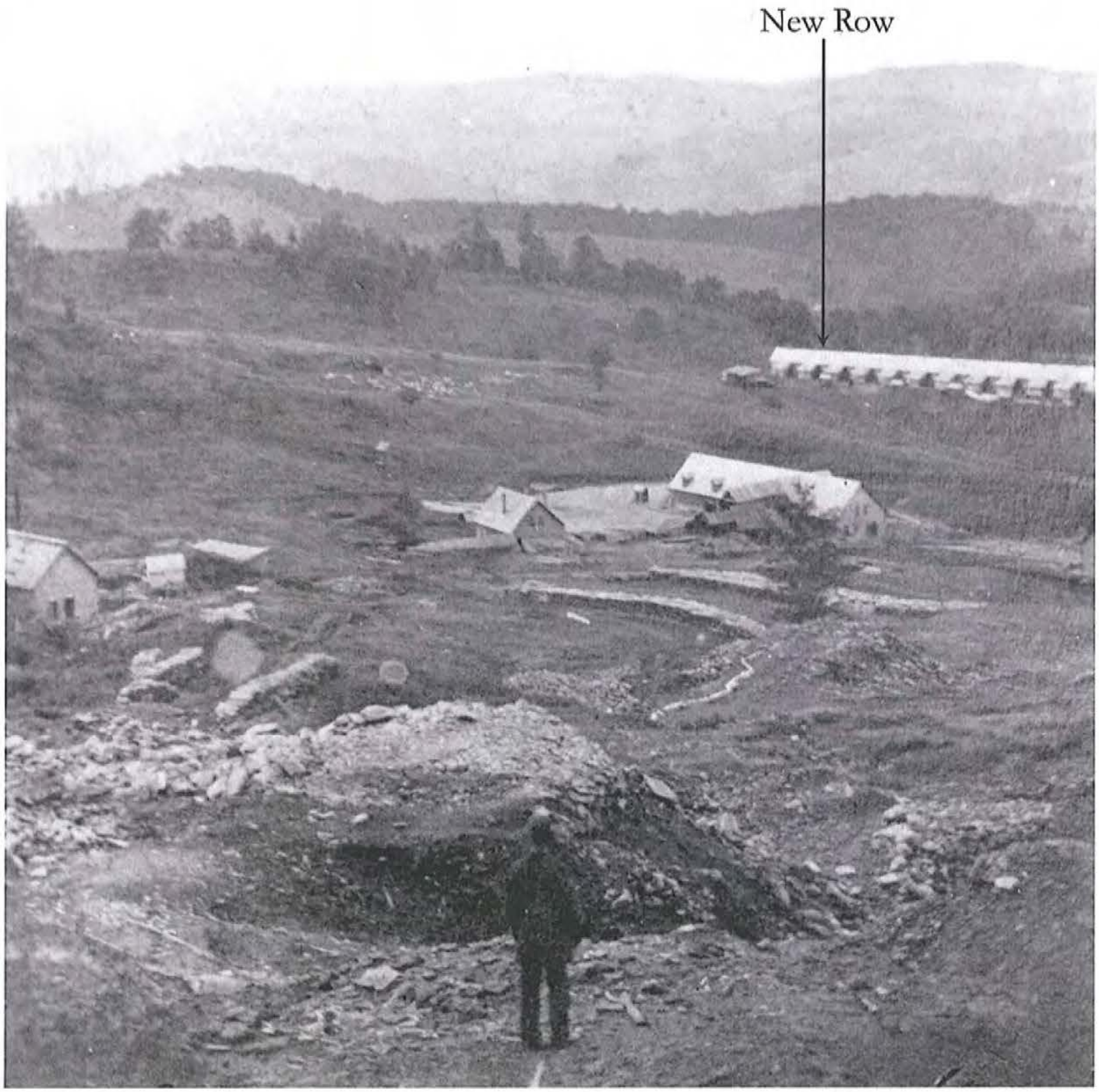

Figure 5-7. Ca. 1880 photograph of the Union Mine, looking northeast (source: http://www.uvm.edu/landscape//).

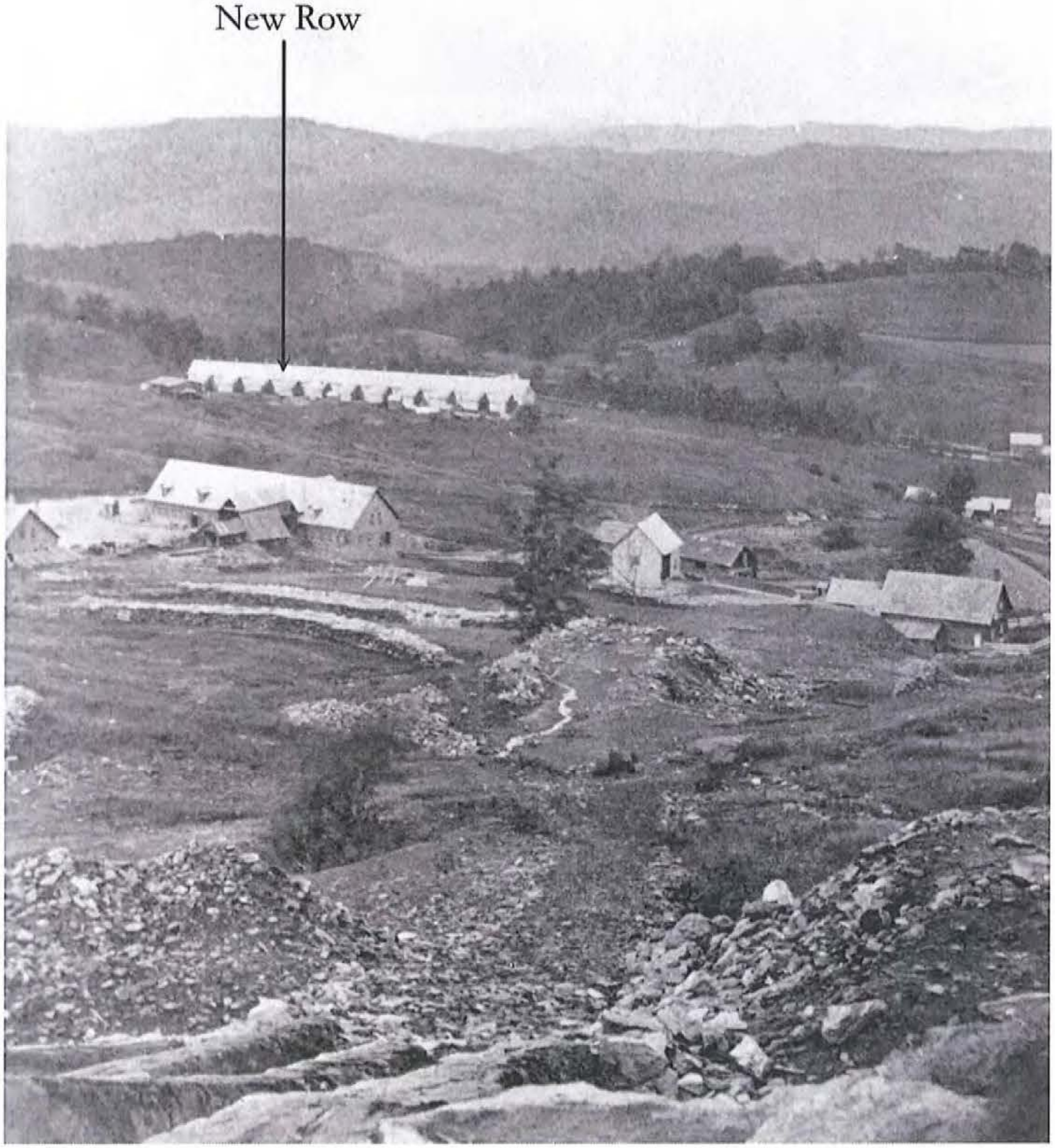

Figure 5-8. Ca. 1880 photograph of the Union Mine, looking northeast (source: http:// www.uvm.edu/landscape//).

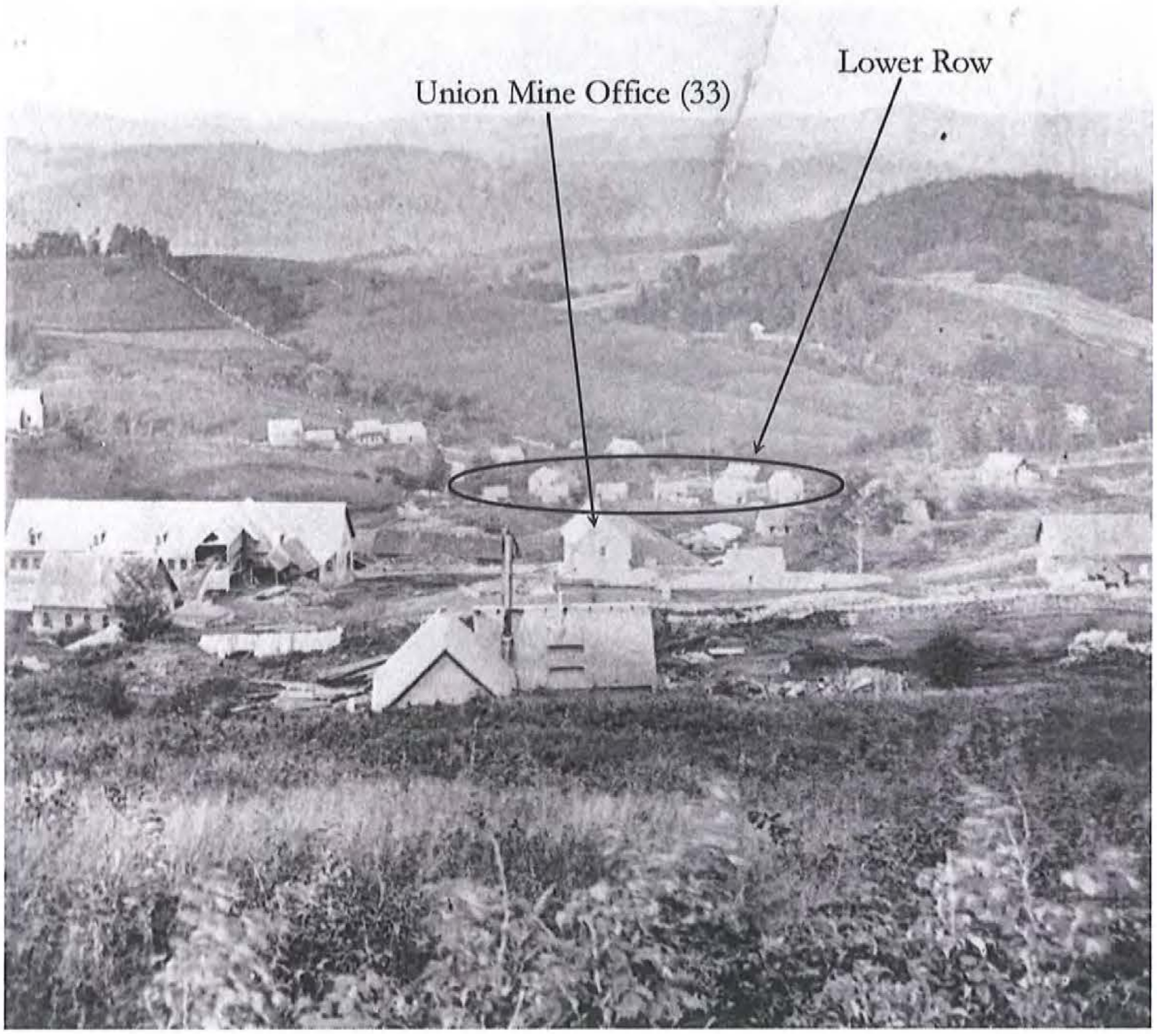

Figure 5-9. Ca. 1880 photograph of the Union Mine, looking east (source: http://www.uvm.edu/landscape//).

The underground workings were accessed by an inclined shaft 900 ft deep, reaching 766 ft below the adit level. Down to a depth of 300 feet, four overlapping lenses of ore with an average thickness of 8 feet were worked. The shaft left the ore 500 feet below the adit level, and continued down in hanging wall.

The lower orebodies were developed by winzes sunk in the footwall. By February 1880, just as the mine had increased production significantly since reopening by the Vermont Copper Mining Company, the ore bed pinched out. The mine all but closed and a few men were retained to try to locate a deeper layer of ore, but the orebody was lost in 1881, and the Vermont Copper Company abandoned the Union Mine in 1882 (Abbott *GMC* 1964:297–299). A in an 1886 *Engineering and Mining Journal* shows a schematic representation of the underground workings at this time (Figure 5-10). The Union Mine ownership was later assumed by the receiver in the Ely Mine chancery suit, Cazin vs Ely et al. (Child 1888:15). According to one source, between 1866 and 1881, the Union Mine produced 31,405 tons of ore averaging 9 percent copper (Weed 1904, 1911).

There was some poorly documented work performed at both mines about 1900, when a company named Hutchinson & Waterman, and another called Darling & Smith, shipped about 300 tons of ore to New York. It was noted at that time that many rich dump heaps from the old sorting of copper ore remained on site (Perkins 1902:84).

In 1904 New York mining consultant John Allen leased the adjacent Eureka Mine, and incorporated as the Pike Hill Mines Company the following year. In 1916 the company acquired the Union Mine, which became part of the Pike Hill Mines Company property and operations (Abbott *GMC* 1964:306–307).

Corinth Copper Company (later Eureka Mine Company)

Mining activity resumed at the Corinth Copper Company mine in August 1863 with the commencement of underground operations. The company sunk an inclined shaft on the orebody at the site of the "Cuprum" mine open cut, and opened up the orebody in underground drifts to the north and south.

According to annual reports, the company employed 52 workers in 1864. The company had sold 244 tons of ore to the Baltimore and Cuba Smelting and Mining Company in Baltimore, MD for $12,742.88. They had 125 tons of ore stored on hand worth $6,006.25, for a total of $18,749.13 worth of ore mined between August 1863 and April 1864. The average price paid for this ore was $53.75 per ton. By 1864 the shaft had been sunk 80 ft, and an adit driven about 112 ft on the hill below and north of the Cuprum shaft. The company's annual report for 1866 recorded 1,755 tons of ore containing an average of 8.5 percent copper mined that year, or about 150 tons per month. The company sold 1,844 tons of ore for $66,583 at prices ranging from $19.89 to $40.80 a ton, for an average of $36.00 a ton. The combined shaft and adit length driven for the year was 508 ft. The company employed 117 workers, and had 500 tons of ore stored at Bradford Station (Farnham 1872:624–625).

This spurt of activity, largely supported by high Civil War copper prices, ended by March 1868, when a combination of falling copper prices, lean ore, high freight rates, and shortage of labor forced the mine to shut down. Another factor was the cost of extraction and new development work; as the mine reached 400 feet in depth, a new 500 ft long adit was driven, but missed the shaft by 75 feet. The mine was subsequently abandoned and the equipment sold off. The upper adit caved in, and the mine quickly flooded (Abbott *GMC* 1964:293–294). According to other sources, the new adit was 1,000 ft long, and driven at a "lower level" to intercept the "lode," which was then called "Eureka." This adit apparently

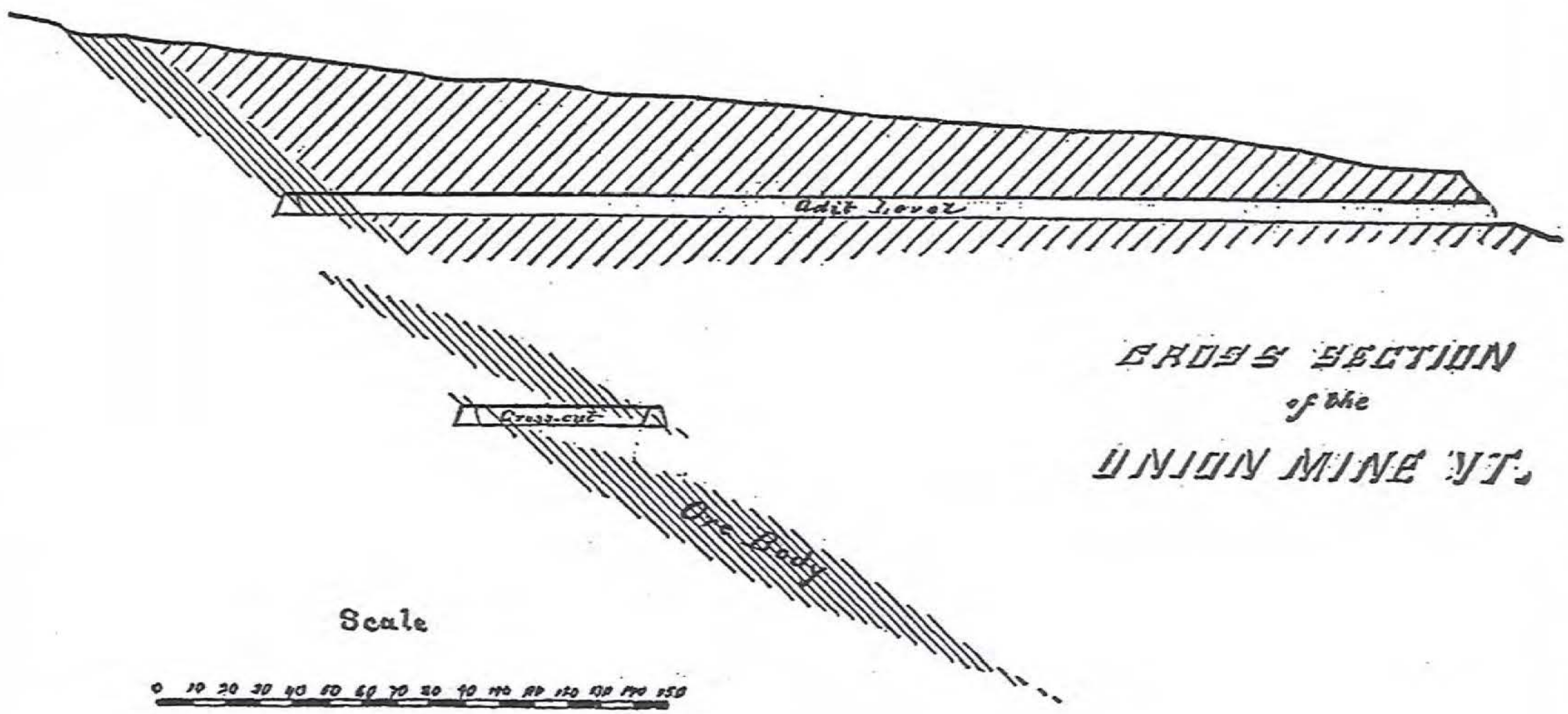

Figure 5-10. Ca. 1886 Union Mine schematic cross section (source: Wendt 1886).

met the upper “Cuprum” lens near its lower end, where it was pinching out. This part of the ore lens proved discouraging, and very little work was done on it in favor of “thicker sections,” possibly meaning lower lenses of ore (Jacobs 1944:11–12; Perkins 1916:198).

Several accounts state that the Corinth Copper Mining Company property remained dormant for the rest of the nineteenth century. However, there was a very brief reopening about 1872, when copper prices rose to 33 cents a lb. The property was leased to Loring L. Lombard in 1872, who made an arrangement with General H.P. Adams to work the Corinth Copper Company deposit with the goal of realizing all the values in the ore, including sulfur, sulfuric acid, and iron as well as copper. Adams shipped 1,269 tons of copper ore over 10 months, but his grandiose plans never came to pass and the mine closed with the Panic of 1873. In 1875 the Corinth Copper Company was reorganized and renamed the Eureka Mining Company (Abbott *GMC* 1964:295–296). The name “Eureka” was thereafter associated with this mine.

Numerous attempts to sell the newly named Eureka Mine property during the 1880s and 1890s failed to attract a legitimate buyer. In 1901, George Westinghouse, who was reopening the Ely Mine, took an option on the Eureka Mine, but abandoned it after partially pumping it out. In 1902, E.L. Smith also tried to reopen the Eureka, briefly switched to the Union Mine, and in 1907 moved again to the mine opened briefly by Isaac Barbour in 1846 on the south slope of Pike Hill (“Smith” Mine) (Abbott *GMC* 1964:298–306).

In 1904 New York mining consultant John Allen leased the Eureka Mine property from L.A. Smith and Darling, who had purchased the mine in 1899. In 1905 Allen and partner Henry H. Knox incorporated as the Pike Hill Mines Company (Abbott *GMC* 1964:306–307).

Knox & Allen immediately pursued underground development at the Eureka Mine. An exploratory underground shaft sunk from the junction of the adit and upper, “Cuprum” orebody located another, deeper lens of high-grade ore 20 feet below the point where the Cuprum lens had pinched out. The combined length of the Cuprum lens and the new lens was 900 feet. These two lenses were then referred to separately as the “Cuprum” and “Eureka” “lodes.” A third lens of ore was soon discovered below the second (Packard 1908:47–48). Information regarding the Eureka shafts and adits for this period is conflicting. According to one account, the Eureka lode was accessed via an adit at about the 300 ft level. Below the adit, a 400 ft inclined shaft descended an additional vertical depth of 125 feet (Packard 1908:47–48). Another source stated that the Eureka was opened by an inclined shaft 500 ft deep with 2 adit levels, the uppermost cutting the “vein” at 200 ft below the outcrop (Weed 1911:33). Another indicated an adit 1,000 ft long, shafts 475 and 200 ft deep, and numerous crosscuts, winzes, and drifts in 1907, and an adit 570 ft long, serving a 330 ft incline in 1907 (McCaskey 1909a:33; 1909b:568). These discrepancies undoubtedly reflect the chronology of mine development and possible inaccuracies in reporting, however, the existence of two shafts and two adits has been confirmed (see Chapter 7). The high grade copper ore was hand cobbed and sent without further treatment to smelters in New York, and the low grade ore was stored for future mill treatment (Jacobs 1942:10–12).

In 1905 Knox & Allen hired mining engineer Harry G. Hunter as general manager. With Hunter’s aid, Knox & Allen designed and erected an ore processing mill (Figures 5-11, 5-12, and 5-13). Hunter installed a 30 to 40 ton per day ore beneficiation system incorporating Wetherill magnetic separation equipment (McCaskey 1909a:33, McCaskey 1909b:568; Perkins 1916:198). In 1906, the Pike Hill Mines Company president was James G. Pirie, and the vice-president was Ernest M. Bowen. The company owned 215 acres including the Cuprum, and Eureka properties, plus mineral rights on an additional 185 acres. The magnetic separation plant started operating in April 1906, and ran continuously until

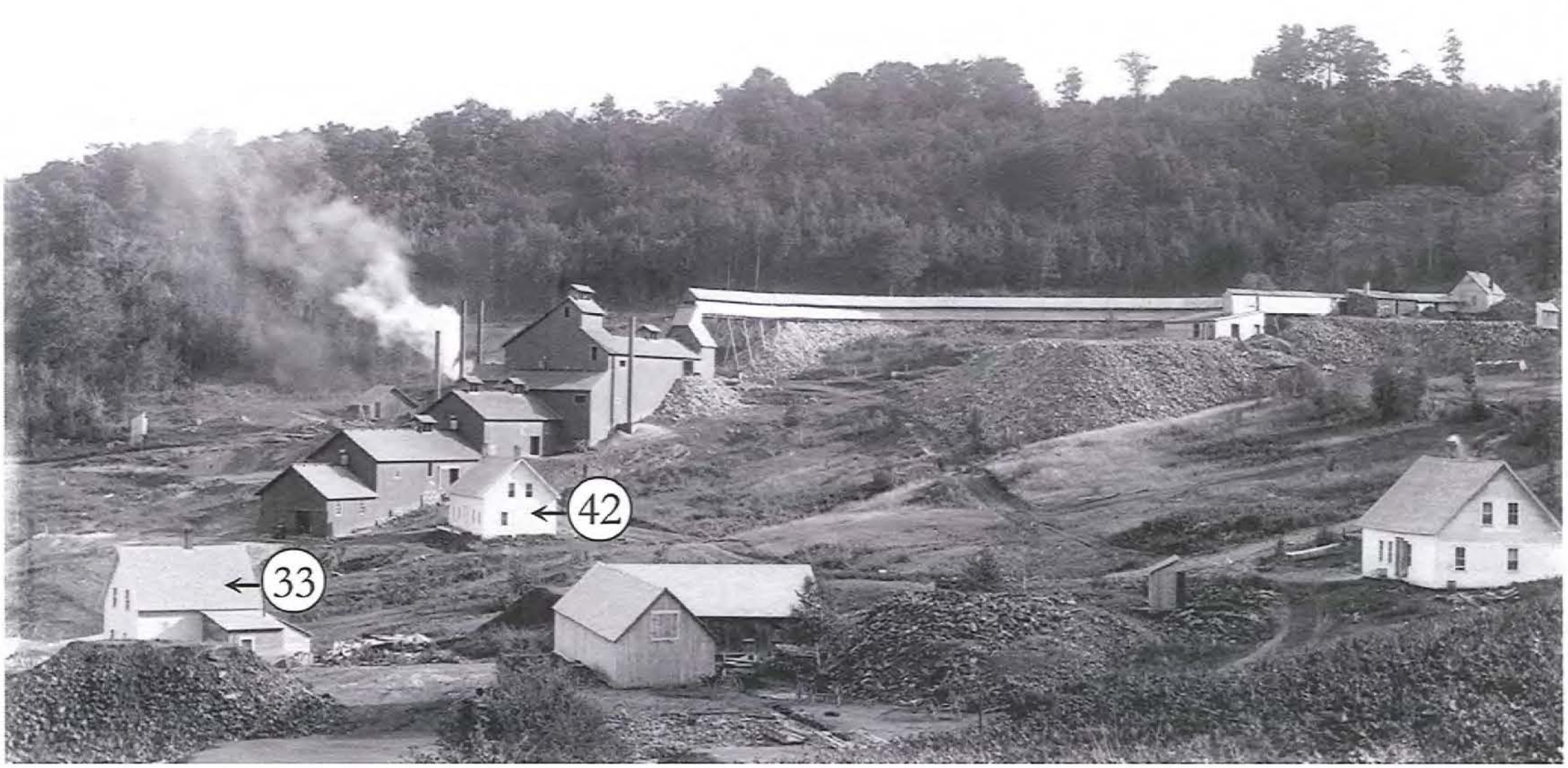

Figure 5-11. Ca. 1900s photograp of the Ore Mill, Pike Hill Mines Co., looking southeast (source: http://www/uvm.edu/landscape//).

Figure 5-12. Early-twentieth-century photograph of the Eureka Mine ore mill, looking southwest (source: http://www.uvm.edu/landscape//).

Figure 5-13. Early-twentieth-century photograph of the Eureka Mine ore mill, looking southwest (source: http://www.uvm.edu/landscape//).

November 1907. Mechanical power in the mill was provided initially by a steam engine, and later by electricity generated by dynamos powered by a pair of gas producers and Otto internal combustion engines. Where magnetic ore separation was never successful at the Elizabeth Mine in South Strafford, it succeeded at Pike Hill using similar technology. Production for the mine for 1905 calculated after offsite refining in New York was 131,911 lbs of copper and 1,698 oz of silver; for 1906, 304,377 lb of copper and 1,698 oz of silver, and for 1907, 425,367 lb of copper and 2,292 oz of silver (Weed 1931:1928). The mill closed in 1907 because of falling copper prices caused by the Panic of 1907 (Abbott *GMC* 1964:306–307). The Eureka mine was not worked in 1908 (Packard 1909b:112).

Eureka and Union Mines United

Roswell Farnham, in his 1872 paper, "Copper Mining in Orange County," said of the Eureka and Union mining properties:

> These two mines are valuable property, and some day will add greatly to the wealth of Orange County and of the State, but they will have to be in the hands of men who have the capital that will enable them to wait until the mines are fully developed before they can hope for permanent profits. Both mines ought to be owned by one company and under the same management, for there two are really but one mine. There have been some efforts made to bring about a consolidation of the two, but nothing has been accomplished yet. Should this take place and the price of copper continue as favorable as at present, the mines will be opened again and Pike Hill will again resound with the sledge and blast of the miner (Farnham 1872:626–627).

The two mines were finally joined into one operation in 1916 when the Pike Hill Mines Company purchased the Union Mine property. This last resuscitation of the Pike Hill mines was prompted by rising copper prices during World War I. The Pike Hill Mining Company determined that it had 90,000 tons of ore available underground for milling, and 45,000 tons of low grade ore on the old mine dumps averaging 1.75 percent copper, and that it would take them five years to mine all the ore "in sight." The Pike Hill Mines Company first contemplated using the "Wood" flotation process as the method of beneficiation, which had been successful in small-scale pilot experiments conducted in their mill between August and October 1915. This process, however, ultimately proved too unreliable to justify large-scale installation. The company experimented with conventional oil flotation beginning in the summer of 1916. Shipments of manually upgraded ore from October 1915 to January 1916 consisted of 210 tons averaging 10 percent copper and 1 ounce of silver per ton. Production of mechanically beneficiated ore concentrates came from the flotation experiments as well as revived magnetic separation equipment. Extensive mill building alterations for the new 100 ton per day capacity flotation mill began in April 1917 and were completed the following September or October, when concentrates production began. The mine employed 40 men, and the shortage of labor was "painfully felt." The plant was powered by electricity from a 13,200 volt Eastern Vermont Public Utilities Corp line from Groton, VT, 15 miles away, and stepped down to 440 volts at the mine. The concentrates were shipped to the Boston & Maine Railroad in Bradford, VT, and railed to the Nichols Copper Company refinery in Laurel Hill, NY. The ore concentrate costs 21 cents a lb to produce, and $3.50 per ton to ship. Production for the mine calculated after offsite refining in New York for 1918 was 509,654 lbs of copper, and 2,056 ounces of silver. The Pike Hill Mining Company ceased operations in 1919 with the fall of copper prices after the end of World War I (Jacobs 1942:10–12; Perkins 1916:198; 1918: 141, 145–146; Weed 1931).

Smith Mine

In 1902, E.L. Smith revived the old Pike Hill name of the Corinth Copper Company. He attempted to reopen the Eureka Mine, briefly switched to the Union Mine, and in 1907 moved again to the Bicknell Mine on the south slope of Pike Hill, the mine opened briefly by Isaac Barbour in 1846. Smith reported a large amount of exploratory work, all in ore, during the first 10 months of 1907. The company developed a 150 ft tunnel and 40 ft crosscut, and was sorting and shipping copper ore in 1908. In 1909 little work was done. Smith apparently worked this mine again in 1913 (Abbott *GMC* 1964:306; Packard 1908:48, 1909:112; McCaskey 1909a:568). In 1944 the workings were reported to consist of a small inclined stope, 70 ft deep, connected to the surface by a 50 ft adit, with an irregular opening in the back of the stope. At the north end close to the ore outcrop was a 40 ft drift and a flooded winze sunk about 40 feet down the dip of the vein below the stope north of the adit (White and Eric 1944:27).

Post-Mining Era History

In 1942, the Elizabeth, Ely, and Pike Hill mines were acquired by the "new" Vermont Copper Co. Inc. formed in 1942 to purchase the Elizabeth Mine. In 1944 the U.S. Bureau of Mines explored and drilled all three mines. At Pike Hill, they located a small, 15,000 ton orebody of sub-marginal ore containing 1 percent copper. They also assayed the waste ore dump piles, and found 20,000 tons of ore averaging 1.6 percent copper. The surveys noted more than 40 small collapsed pits and trenches between the Smith and Eureka mines, all devoid of massive sulfide ore. Their arrangement was said to show a "keen understanding of the structure of the area" (White and Eric 1944:28). The U.S. Bureau of Mines report included a mine site map showing the mine surface and underground workings and contours as well as footprints for several mine buildings standing at the time (Figure 5-14). The Pike Hill Mines were never reopened for underground mining. During the late 1940s or early 1950s, portions of the ore dumps were trucked to the Elizabeth Mine to increase the volume of ore at the flotation mill there. The property ownership passed to Appalachian Sulfides Inc. when it bought the Vermont Copper Company holdings and Orange County copper mining rights in 1954. The last buildings at Pike Hill were destroyed by fire in 1960. In 1962, Appalachian Sulfides, Inc. sold the Pike Hill property to Pat Mines Inc., also known as North Gate Exploration, a Canadian company from Toronto. Pat Mines still owned the property in 1983 (Abbott *GMC* 1964:306–307; Blaisdell 1982:71; Jacobs 1944:3; Roy F. Weston 1983:9; USBM 1944).

Since about 1950, when the last waste rock was hauled away to the Elizabeth Mine, the Pike Hill Mines site has remained largely undisturbed. The forests on the once-denuded hillsides have grown back, and some acid-tolerant species including aspen, birch and pine have begun to encroach on the still-barren dump piles. Logging and recreational activity has kept many of the historic mine roads open. In 1993, a portion of the flotation tailings immediately east of the Ore Mill began to spontaneously combust (Roy F. Weston Inc. 1993). The efforts to extinguish the smoldering pyrrhotite iron sulfide flotation mill tailings fire may have resulted in alteration of the historic landscape in the immediate area.

Although the Pike Hill mines operated sporadically and were only a shadow of the Ely and Elizabeth mines, they did contribute an estimated 8,600,000 lbs of copper to Vermont's overall production, about 1/17th based on analysis of known production figures. The Eureka Mine probably contributed about 3 million lbs, and the Union about 5.6 million lbs (Abbott *GMC* 1964:444–448; White and Eric 1944:24). The Eureka Mine's other contribution was technological, as it was the only site of successful magnetic ore separation in the Vermont Copper Belt, in 1906 and 1907.

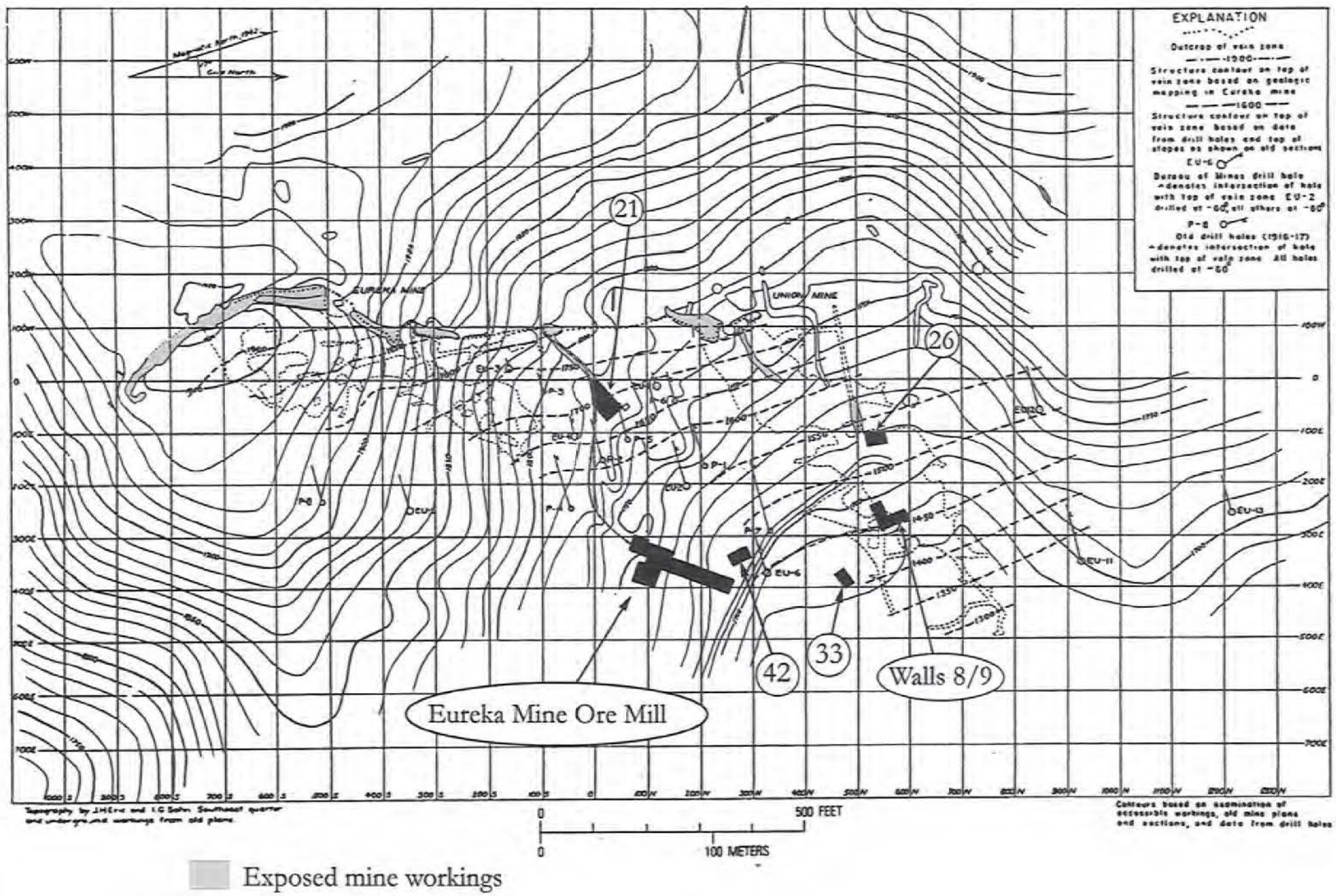

Figure 5-14. Structure contour map of the ore zone of the Pike Hill Mines (source: White and Eric 1944).

CHAPTER SIX

HISTORIC INDUSTRIAL PROCESSES

Introduction

Chapter 5 presented the social and industrial history of the Pike Hill Mines site. Chapter 6 presents additional discussion and context for some of the more significant industrial processes and associated features at Pike Hill. This chapter provides additional basis for the interpretation of some of the features within the industrial archaeological subsites discussed in Chapter 7.

The Union and Eureka mines together were much smaller and more short-lived than the Elizabeth or Ely mines. The quantity of surviving documentary evidence available to interpret the Pike Hill mining operations and the appearance of the resulting features and landscape is also far less than for the larger copper mines to the south. No Pike Hill surface or underground site maps have been located that date prior to the 1944 U.S. Bureau of Mines detail map of the immediate area over the mined out portions of the orebody (White & Eric 1944) (see Figure 5-14). Photographic evidence of the overall landscape is limited to a series of a half-dozen photographs dating from the peak of ca. 1880 Union Mine activity (see Figures 5-6 through 5-9), and one of the Eureka Mine ore mill and surrounding buildings from the early-twentieth-century operations (see Figure 5-11). The Pike Hill mines' requirements for transportation, materials handling, water collection, and waste rock and tailings disposal were fewer than the Elizabeth or Ely mines, and the collective impact of these activities on the landscape was comparatively smaller. Mine openings, transportation, water, materials handling, and waste pile features are therefore simply described and interpreted in the following chapter.

Unlike the larger and more complex Elizabeth or Ely mines, which included ore roasting and smelting operations, Pike Hill industrial activity was limited to mining and beneficiating (raising the percentage content of desired metal) of the ore for shipment for further refining offsite. This activity included one notechnological achievement, the only successful application of magnetic ore separation in the Vermont Copper Belt. This chapter will therefore focus on discussion of ore beneficiation processes and their associated remains and waste materials. It will also include discussion of some unusual surviving hoisting and power generation features.

Ore Beneficiation

The term "ore" is an economic term as well as a geological one. An ore is a rock or mineral that contains an economically recoverable percentage of a useful material. A rock can be worthless one day, and an ore the next, depending on general economic and technological factors including market price of the contained material and the availability of technology to efficiently extract it, and other, site-specific costs including labor, fuel, and transportation.

The ores of the Vermont Copper Belt are massive metallic sulfides consisting of an intimate mix of the iron sulfide mineral pyrrhotite and the iron-copper sulfide mineral chalcopyrite. The silver-bronzecolored pyrrhotite made up the bulk of the ore, with clearly visibly identifiable yellow-green copper-bearing chalcopyrite embedded in it randomly in pods, swirls, and flecks. At Pike Hill, the ore was richer in copper than the ore at the Ely or Elizabeth mines, that is there was more chalcopyrite per given volume of ore. At Pike Hill, the ore was also coarser in texture, with more, larger zones of chalcopyrite within the pyrrhotite. This made the Pike Hill ore easier to break into pieces to sort out the copper-bearing portion. Despite the comparative richness of the ore, the Pike Hill deposits were much smaller than those at the two larger mines to the south. The tenor and overall quantity of ore at Pike Hill influenced decisions about capital investment in on-site ore processing plants versus transportation to offsite refining operations. Throughout the life of the mines at Pike Hill, raw, "run-of-mine" ore was manually sorted to upgrade it for shipment for offsite smelting and refining. As beneficiation technology improved in the early twentieth century, equipment was installed at Pike Hill so that the lower grade ores could be economically concentrated prior to shipment offsite.

This history of beneficiation processes at Pike Hill is organized in a chronological fashion, following the progression and evolution of ore processing at the Union and Eureka mine subsites. The site topography at both the Eureka and Union mines was well suited to the logical downhill progression of the mining and ore processing steps, and the mine plants were laid out to take advantage of the topography. However, because there were two adjacent mines operating at different times, extracting ore from multiple openings, shipping some materials and rejecting others in waste piles—that were subsequently disturbed by later recycling operations—the expression of the successive beneficiation steps, from manual "high-grading," to mechanical processing, to waste disposal, in the landscape, is complicated.

Manual and Mechanical Upgrading

From the earliest days of mining at Pike Hill and up to and including the 1904-1907 phase, the raw, run-of-mine ore was broken and sorted to raise the percentage of copper. The pieces of run-of-mine ore, which ranged widely in size, were visually and manually sorted to remove individual pieces of rich ore that required no further treatment. The remaining lower-grade ore was then "cobbed," or broken with special short-handled sledge hammers to separate the chalcopyrite-bearing ore from the barren matrix. Often the broken ore, and the dust or "fines" from cobbing, were washed and processed to collect the chalcopyrite particles. This crude beneficiation method could raise the percentage of copper in the ore by volume to 8 to 10 percent, the most economical copper content for direct shipping to smelters without further on-site processing. The richer, coarser Pike Hill ore was more economical to process this way than the finer, slightly lower-grade Ely or Elizabeth ores, a difference that was taken advantage of throughout the life of the Pike Hill Mines. Indeed, as late as 1916, high grade ore was manually separated and shipped offsite without further treatment (Jacobs 1918:147).

The simple process described above was essentially universal to nineteenth- and early-twentieth-century metallic ore mining practice at small, remote mines. Although no nineteenth-century documentation for mechanical equipment at Pike Hill survives, the initial separation process and machinery were undoubtedly similar to, or even cruder than, those in use at the Ely and Elizabeth mines at the same time.

In 1878 the Ely Smelter began to process ore from the Pike Hill mines. That ore was cobbed and washed at Pike Hill, presumably in the Upper Cobbing House, separated into coarse ore and fines, and brought by wagon to Ely. The cobbing process at the Union Mine was recorded in one oral account from a mine visitor dating from the late 1870s era when the Vermont Copper Company was first shipping ore to the smelter at the Ely Mine:

> It was during this period of its greatest activity that I became more or less familiar with the mine and its workings. . . . The loads were dumped into a room with a stone floor—the cobbing house – where two or more men with heavy hammers broke it still finer into something like walnut size. No crushers in those days. The ore and rock mixture was then sluiced down an inclined spout in a stream of water. A row of boys standing along this spout were busy picking out the worthless rock. . . . The good ore and fine particles dropped from the lower end of the spout onto a smooth floor where the water drained away, and it was from this pile, or bin, that the ore wagons were loaded for the trip to Mr. Ely's smelting works (Blaisdell 1982:71–72).

This process appears crude even for the Vermont mines at this time, for it clearly did not include primary mechanical crushing. At the Ely Mine, a steam-powered mechanical crusher was in use as early as 1859 (Rittler 1859:15). An 1859 account of the ore handling, sorting, and deposition of low-grade ore and waste rock at Ely Mine by mining engineer Herman Rittler is useful for understanding how ore was likely handled once it reached the surface at Pike Hill during the 1860s–1880s mining campaigns. According to Rittler, the ore was:

> separated in the mine from the rock, iron pyrites, &c., and carried out in cars. . . . The [mine] railroad . . . leads to the upper slope: here the car is dumped, and the ore carried to a platform, where it is separated; the good ore is loaded into a car, and carried on a railroad, eighty-five feet, to the lower slope: here the car is dumped, and all the ore is carried down to a platform, from whence it is loaded into wagons, and carried to the washhouse [cobbing house]. On the upper platform the ore is separated. The poor ore, light waste, and fine ore, generally yielding from two to three percent [copper], is kept separate, and large heaps of hundreds of tons are piled up high on both sides of the platform (Rittler 1859:7).

At Pike Hill, the large vegetated and unvegetated piles of waste material below the Upper Cobbing House and Lower Cobbing House are the low-grade ore from Union Mine cobbing operations. Although there are no accounts of the ore processing machinery or flow for the Corinth Copper Company Mine for the nineteenth century, the dump piles within the upper areas of the Eureka Mine landscape above the Ore Mill undoubtedly consist of low-grade ore from cobbing and manual separation operations as well as barren mine development rock.

In 1879, the fine ore shipped from the Union Mine at Pike Hill to the Ely Mine was reportedly processed at Ely in a "jigging house . . . erected for washing it" (*Bradford Opinion* 1879). By May 1879 a "new washhouse" was built at Pike Hill and the ore processing plant was enlarged to accommodate new jigging machines for separating fine ore and waste. In October, the washhouse burned, putting almost 150 men out of work. It was quickly rebuilt. (Abbott *GMC* 1964: 297–299). The "new washhouse" appears to refer to the Lower Cobbing House seen in the ca. 1880 photographs.

Mid-1870s accounts of ore processing at the Ely Mine explain the function of the washing and "jigging" machines. In 1872, the ore was "washed or separated by water, the heavier copper ore sinking to the bottom, and the lighter rock and iron pyrites being washed off," indicating that fines were being classified for their copper content (Collier 1872:628–634). At Ely Mine in 1876, the cobbed ore was screened to separate it into coarse, medium, and fine sizes. The fines were separated in a jig, or water-filled sieve where the heavier ore sank to the bottom and the waste material was scraped off the top (*Argus and Patriot* 1876).

The jigs used at Pike Hill were very likely manual "hand jigs" (Figure 6-1) considering the volume of ore, remote location, and lack of steam engine boiler smokestacks on the roofs of the Upper Cobbing House and Lower Cobbing House in the ca. 1880 photographs. Jigging takes advantage of the difference in specific gravity between heavier metallic and lighter non-metallic particles. A mixture of mineral particles several inches deep is placed in a box with a screen at the bottom, which is suspended in a tank of water. Separation of the larger, heavier and the smaller, lighter particles is accomplished by moving the box up and down. Quick downward plunges forces water up through the screen and the ore, causing classification, and each following upward plunge accentuates the classifying action (Hayward 1929:4–5).

The Union Mine's jigging capacity at the height of operations for the Ely Mine smelter was considerable; in 1879 and 1880, the Union mine shipped 5,712,604 lbs of "fines" averaging of 2.7 to 4.5 percent copper to the Ely Smelter (Weed 1904, 1911). The waste rock fines that were separated from the sulfide ores as part of the jigging process are presumably also contained in the large vegetated and unvegetated piles of waste material below the Upper Cobbing House and Lower Cobbing House. There are no accounts of the ore processing machinery or flow for the Corinth Copper Company Mine for the nineteenth century; it is unknown whether that activity and resulting dump piles in the Eureka Mine landscape includes ore jigging or waste fines.

These washing and jigging processes recovered the heavier copper-bearing chalcopyrite from the lighter waste rock fines, but also included the heavier iron sulfide mineral pyrrhotite, which contained no copper. It was not until the early twentieth century, with the advent of magnetic separation and flotation technology, that fine particles of different sulfide ores could be separated from each other.

Twentieth-Century Technology

U.S. demand for copper rose sharply at the end of the nineteenth century, as it was a key component for electrical communication and power technology equipment emerging at that time. As high-grade copper deposits were quickly worked out, the need for more and more copper drove metallurgists to develop processes to efficiently extract copper from leaner and leaner ores and even from slag, mill tailings and old waste rock. New processing technology, electrically powered equipment, and the application of mass-production techniques allowed savings in fuel and labor and the realization of greater and greater economies of scale in mining. Ultimately these advances made possible the profimining and milling of immense low-grade deposits in open pits. Some of the new processes that were tried in the Vermont Copper Belt included magnetic separation, pyritic smelting, and froth flotation. None of the Vermont trials of this equipment were on the cutting edge of technology or influenced subsequent metallurgical practice. They were incorporated there simply in a dogged effort to make a known large copper deposit a paying proposition. The reasons for failure included idiosyncrasies in the ore, labor shortages, poor capitalization, and transportation difficulties.

Magnetic Separation

Magnetic separation was an old idea that had been used successfully in iron ore enrichment as early as the early nineteenth century, for instance, at the mines associated with the Franconia, New Hampshire, iron furnace. It experienced a revitalization and successful application with the early-twentieth-century advent of industrial electrification. Pike Hill is the only site at which this process was successfully applied in the Vermont Copper Belt.

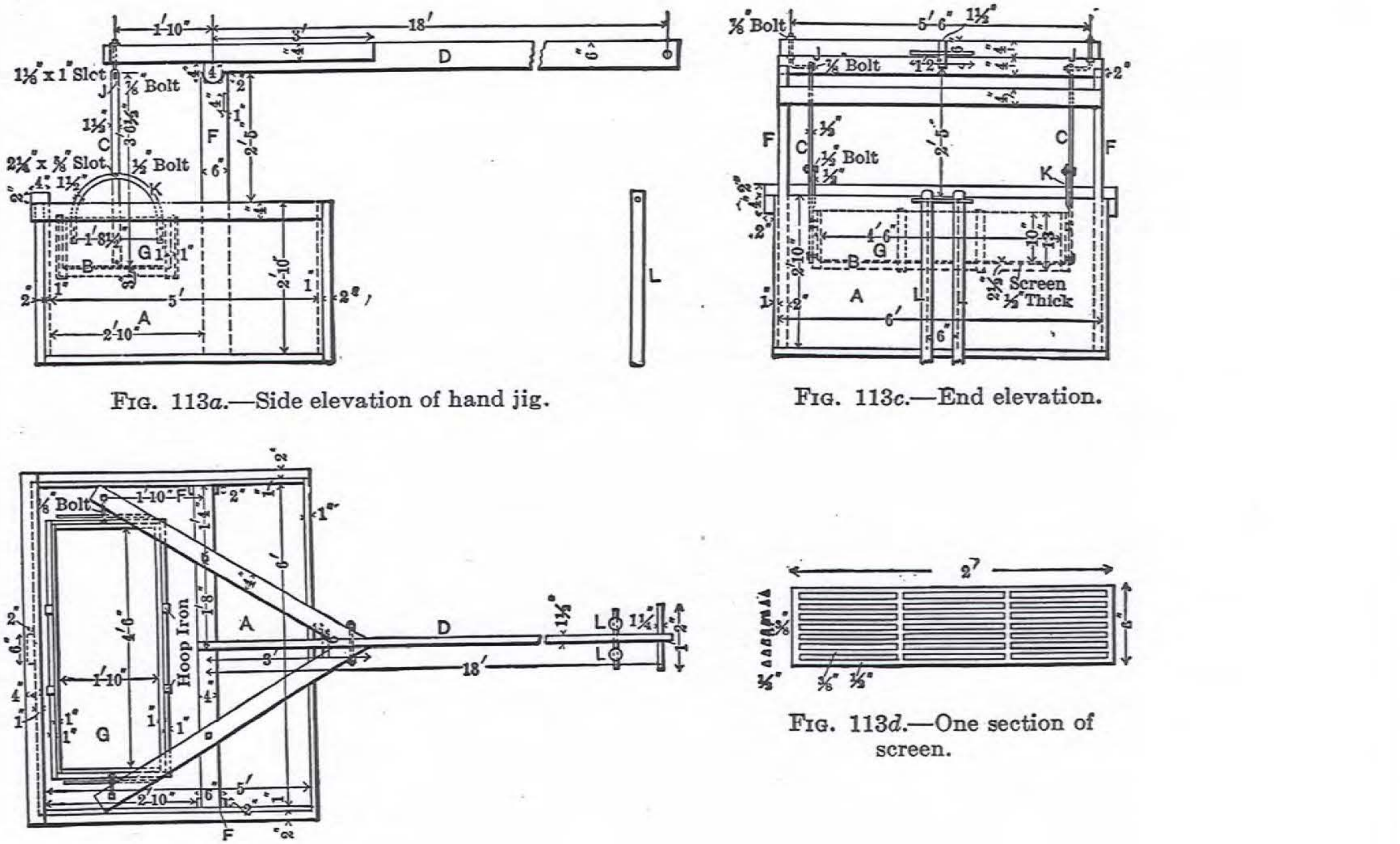

Figure 6-1. Technical illustration of hand jig (source: Richards and Locke 1925:172).

Magnetic separation was easy to effect in situations where one constituent of the ore was strongly magnetic, and the other weakly or non-magnetic. The challenge for metallurgists had always been to separate weakly magnetic minerals from each other. The problem was solved by Lewis G. Rowand, inventor of the Wetherill (or Wetherill-Rowand) Type "E" magnetic ore separator (Judson 1904:3).

The Wetherill separator, patented in 1902, consists of a horizontal endless loop feed belt, 6 to 18 inches wide, driven by an electric motor (Figures 6-2, 6-3, and 6-4). Finely ground material containing particles of varying magnetism are gravity-fed onto one end of the moving belt through a hopper. The belt and its load passes through a series of convergent magnetic fields produced by anywhere from one to four pairs of horseshoe magnets spaced above and below the belt with opposed, moveable flat and wedge-shaped poles, anywhere from 1¼ to ¾ inches apart. The magnets are energized by direct current and wound so that opposing poles are of opposite polarity. The field strength can be regulated to increase the efficiency of the process. Above the feed belt, between each set of poles, is a perpendicular cross belt that rotates at a 90-degree angle to the main feed belt. As the ground feed material enters the field between the magnetic poles, it is drawn upward by magnetism, and carried off to the side on contact with the rotation cross belt by friction. The magnetic "heads" are discharged into a bin. The non-magnetic "tails" that run off the end of the main feed belt are either saved for recirculation through the machine, or discarded (Taggart 1945:13:23–24).

This machine was particularly suited to separating polymetallic sulfide ores where the metallic constituents were of varying magnetism, after the ore was crushed to fines in a conventional crushing circuit, dried, and sized. For pyrrhotite-chalcopyrite ores like those of the Vermont Copper Belt, the crushed ore was passed once through a Wetherill machine to remove the bulk of the magnetic pyrrhotite from the nonmagnetic chalcopyrite and gangue (waste material). The pyrrhotite was discarded, or sold for its sulfur and/or iron content. The remaining non-magnetic chalcopyrite and gangue was then roasted to eliminate some sulfur, and partially oxidize some of the iron in the chalcopyrite, making it weakly magnetic. The roasted mixture was passed through a second Wetherill machine to separate the more magnetic chalcopyrite from the non-magnetic constituents of the gangue (Judson 1904:13–14).

In 1904 Lewis G. Rowand and John H. Judson of New York, who were both involved in the development of the Wetherill ore separator, leased the Elizabeth Mine at South Strafford. Judson was a Director of the Wetherill Separating Company, and was later employed for several years by the American Metal Company, Ltd., who briefly operated the Elizabeth Mine in 1925. They set up a pilot plant to test electromagnetic separation of the pyrrhotite from the chalcopyrite in the Elizabeth Mine ore, however, the pyrrhotite from that mine proved difficult to magnetize and the process ultimately failed there due to vagaries in the ore (Abbott *GMC* 1964:278–281). This experiment was an application of a reasonably established technology to an unworkable ore, and is related to the successful application of magnetic separation carried out at Pike Hill in 1907–1909. Judson and Rowand also carried out experiments with ore from the Ely and Pike Hill mines. They concluded that although the magnetism of pyrrhotite from Elizabeth and Ely was very low, only slightly more than the garnet found in the gangue, tests of Pike Hill ores indicated that "the pyrrhotite from this mine proved to be considerably more magnetic than that of the other properties" (Judson 1904:14, 17).

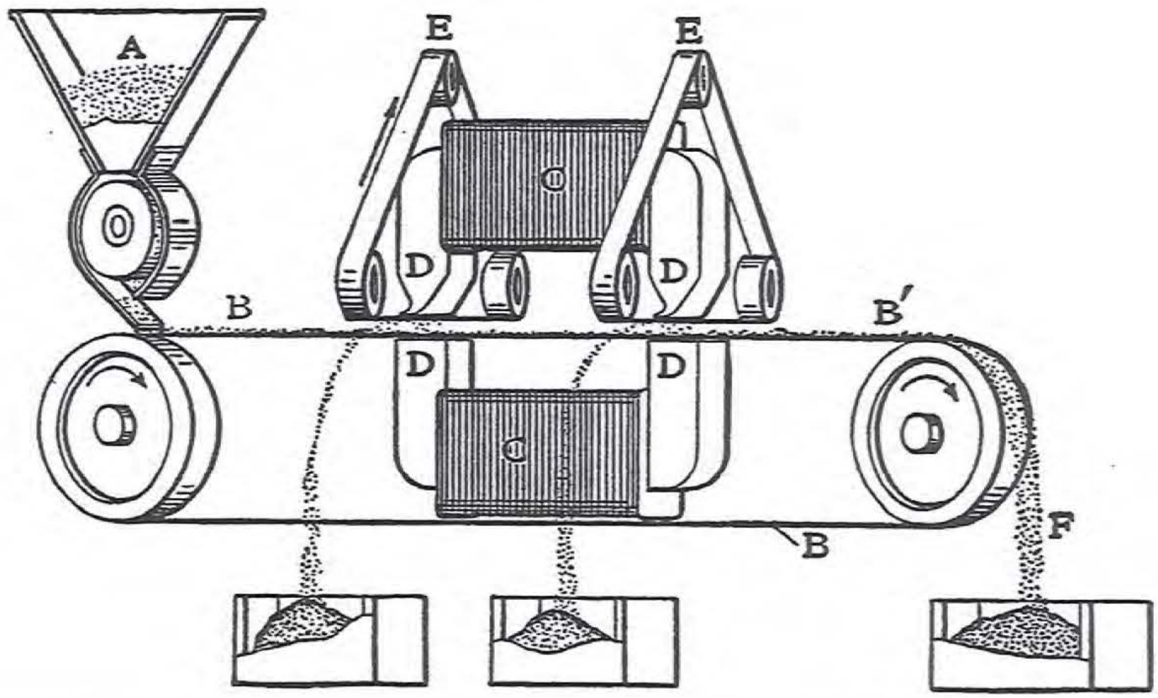

FIG. 32.—SKETCH SHOWING PRINCIPLE OF WETHERILL-ROWAND SEPARATOR.

A, Feed hopper; *B–B′*, conveyor belt; *C*, coils; *D*, magnet poles; *E*, cross belts; *F*, nonmagnetic discharge.

Figure 6-2. Schematic illustration of Wetherill magnetic separator (source: Gunther 1909:61).

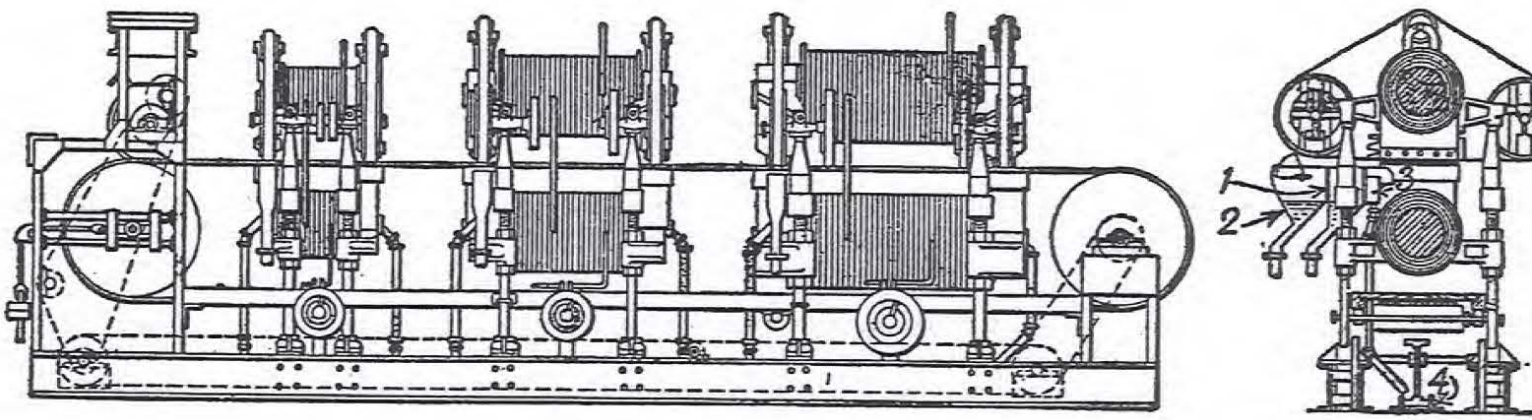

Figure 6-3. Technical illustration of Wetherill magnetic separator (source: Taggart 1945:13:24).

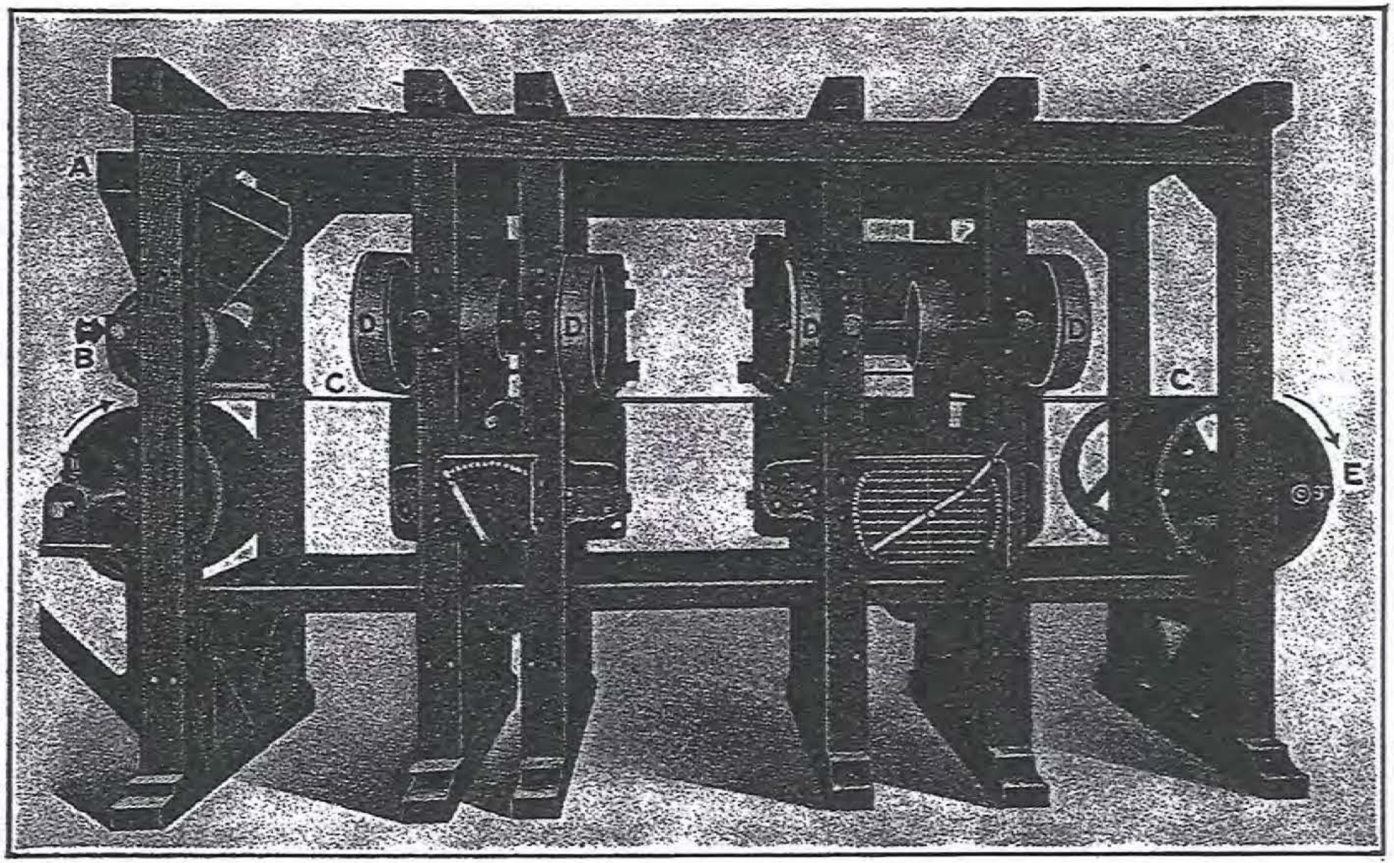

FIG. 33.—WETHERILL-ROWAND SEPARATOR.

A, Feed hopper; *B*, feed roller; *C*, conveyor belt; *D*, cross belts; *E*, nonmagnetic discharge.

Figure 6-4. Illustration of Wetherill magnetic separator (source: Gunther 1909:62).

In 1905 Knox & Allen, who had acquired the Eureka Mine property the previous year, hired mining engineer Harry G. Hunter as general manager. The Pike Hill Mines Company built a 30 to 40 ton per day Wetherill magnetic separation plant (McCaskey 1909a:33, McCaskey 1909b:568; Perkins 1916:198) (see Figures 5-11, 5-12, and 5-13). The magnetic separation plant started operating in April 1906. The plant was initially powered by a steam engine. By the winter of 1907, the electricity required for the Wetherill electromagnets and motors was provided by dynamos driven by two Otto internal combustion engines fueled by a gas producer. The crushing process for the selected ore that preceded feeding the fines to the Wetherill machines was conventional for its time (Figure 6-5). Most of these types of crushing and sizing equipment are discussed in the Ely Mine and Elizabeth Mine reports.

In 1909, the specific process and equipment used by the Pike Hill Mines Co. at the Eureka Mine as described by Harry G. Hunter was included in a mining engineering monograph on magnetic separation:

> At Corinth, VT, the Pike Hill Mines Co. is employing the Wetherill-Rowand separator in separating the pyrrhotite and chalcopyrite from the gangue and from each other. The ore carries pyrrhotite and chalcopyrite in a quartz and mica schist gangue; the run of mine ore is cobbed to run 3 percent copper before going to the mill. The cobbed ore is dry-crushed through 10 mesh, and screened into two sizes, through 20 mesh, and through 10 on 20 mesh. The two sizes are run separately through the separators as they require different adjustments in the height of the magnets and intensity of the field. The crushed ore is fed to a Wetherill-Rowand type E separator, which removes the pyrrhotite; the pyrrhotite carries 0.5 percent copper, and is stacked for further use in smelting silicious ores. The residue passing from the separator, consisting of chalcopyrite and gangue, is passed through a revolving-cylinder furnace, and giving a slight roast, sufficient to form a film of magnetic sulfide on the chalcopyrite particles. The ore passing from the furnace is cooled and fed to a second Wetherill separator (Figure 6-6), which removes the chalcopyrite as a magnetic product; the concentrate from this machine carries from 12 to 20 percent copper, and the tailings from 0.2 to 0.5 percent copper, varying with the ore and the amount put through (Gunther 1909:154).

The Pike Hill Mines Co. magnetic separation process operated continuously from April 1906 until November 1907 (Perkins 1916:198–199). The concentrated product was shipped out in cloth bags. Production for the mine for 1905 calculated after offsite refining in New York was 131,911 lbs of copper and 1,698 oz of silver; for 1906, 304,377 lb of copper and 1,698 oz of silver; and for 1907, 425,367 lb of copper and 2,292 oz of silver (Weed 1931:1928).

The magnetic separation process left two types of finely ground waste material: the iron sulfide mineral pyrrhotite from the first pass through the Wetherill "pyrrhotite" machines, and non-sulfidic, non-magnetic gangue consisting of particles of quartz-mica schist. The gangue fines are a light gray color, easily distinguished from the yellow, more finely textured flotation mill tailings. These were dumped in broad fans below the Ore Mill and its adjacent access road, and are easily distinguished from the later, yellow, more finely-textured flotation tailings that partially cover them. It is is unclear where the pyrrhotite tailings were deposited. They are clearly not intermingled with the gangue tailings. They may have been shipped offsite, or deposited in a separate area. It is possible that the tailings fire discovered in the early 1980s southeast of the mill may have been in pyrrhotite tailings, which are known to spontaneously combust. The visible volume of magnetic separation tailings suggests that some of this material may have eroded and washed into the wooded area below the Ore Mill.

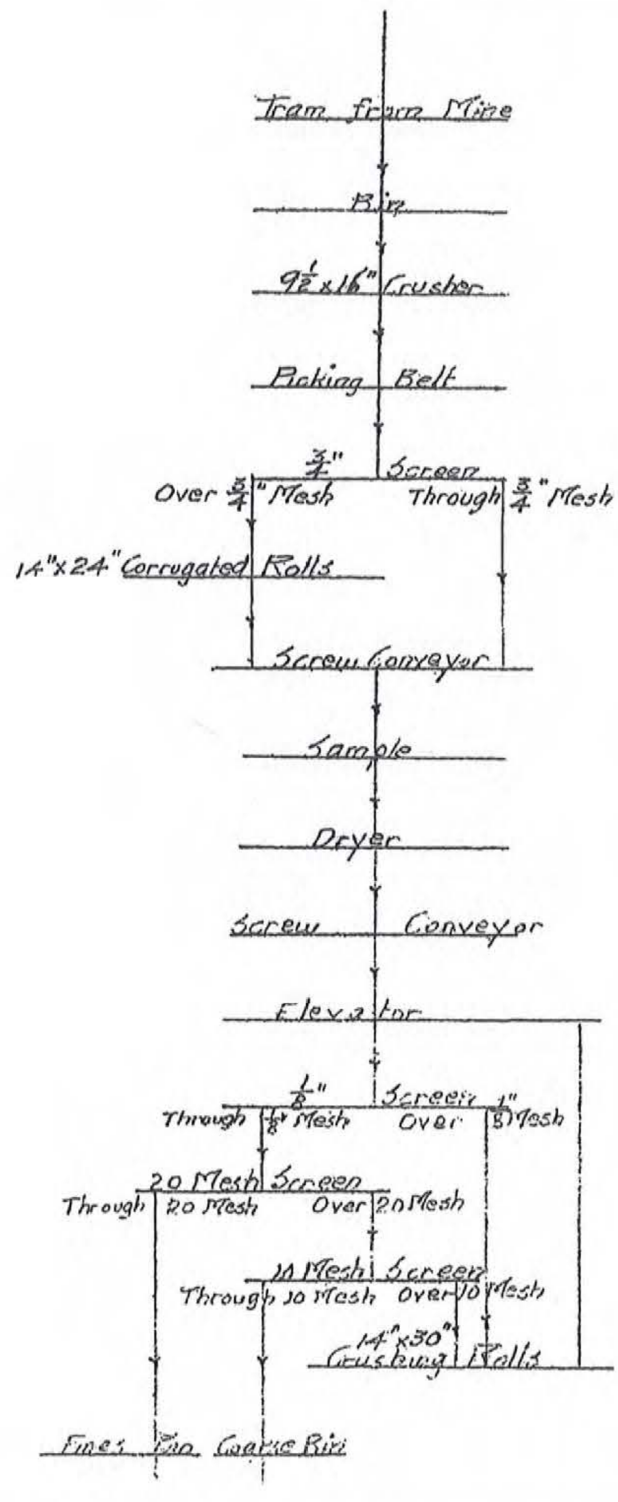

Figure 6-5. Flow Sheet of Pike Hill Mines Co. Crushing Mill, 1906 (source: Pike Hill Mines Co. 1906).

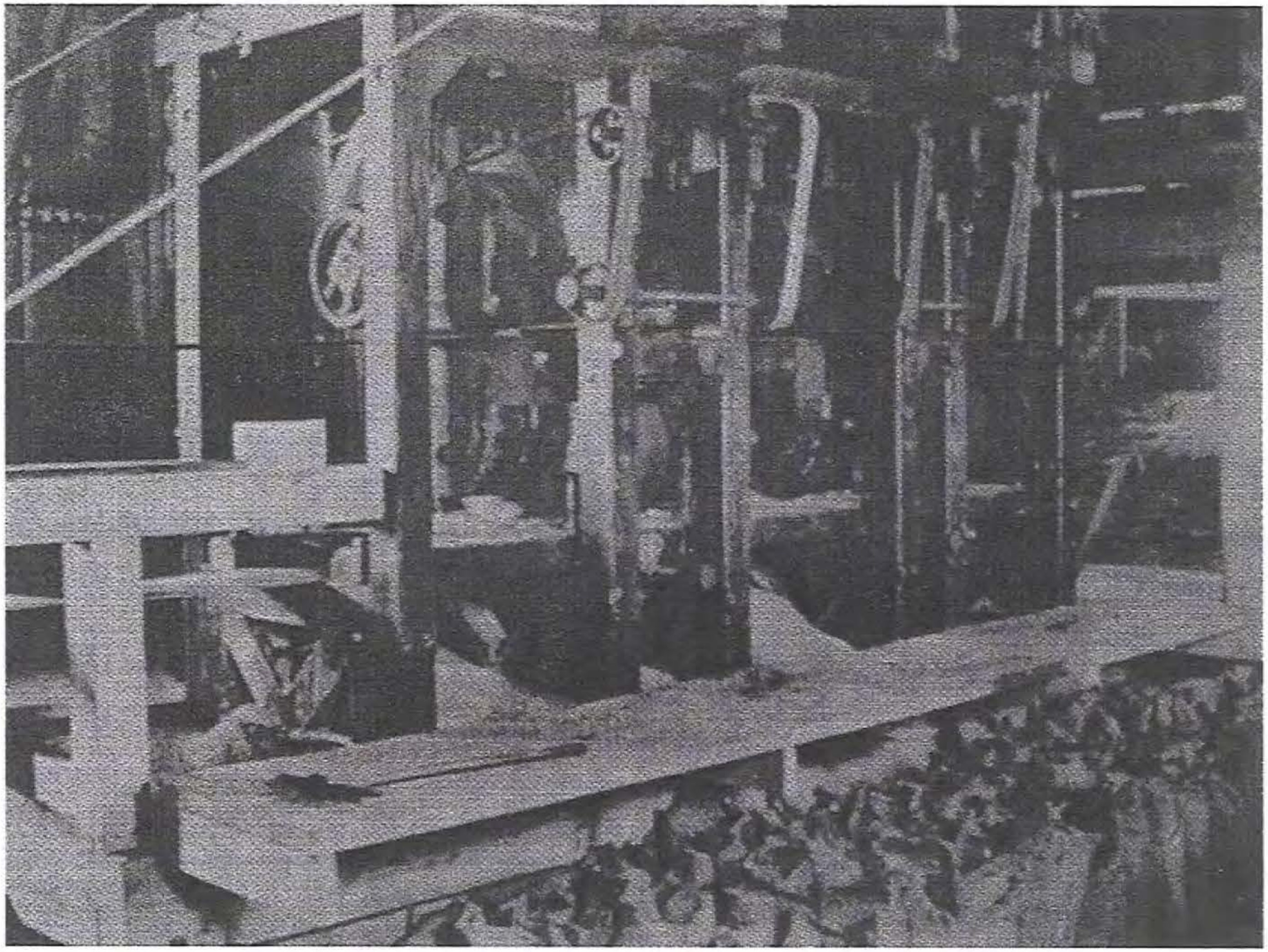

Figure 6-6. Photograph of Pike Hill Mines Co. Wetherill magnetic separator (chalcopyrite machine), ca. 1907 (source: Blaisdell 1982:74).

Flotation

The Pike Hill Mines Company purchased the Union Mine property in 1916 and resumed operations to take advantage of rising copper prices during World War I. The Pike Hill Mining Company determined that it had 135,000 tons of ore underground and in the waste dumps. The dump material had been worthless until the advent of flotation technology, which enabled the extraction of copper and other metals from old mine waste dumps, and more importantly, from large, fresh ore deposits of previously uneconomically low grade.

The Pike Hill Mines Company first contemplated using the "Wood" flotation process as the method of beneficiation, which had been successful in small-scale pilot experiments conducted in their mill between August and October 1915. The Wood process, patented in 1914, is unlike the more effective froth flotation process that superseded it, as it makes use of water only as separation medium. It is a so-called "skin flotation" method, which relies on the interaction of mineral particles with the surface tension of water (Taggart 1945:12:51). Different minerals are more or less "hydrophobic," and smaller particles may be carried more by surface tension than larger particles. According to a description of the Wood process as applied at Pike Hill:

> The ore, ground to 40 mesh size and thoroughly dried, is showered upon the surface of water contained in an oblong box, having a longitudinal partition extending to the bottom. The side walls of the box converge to this partition, near the bottom, assuming a V-shaped cross section. Near one edge of the box the ore strokes the surface, where fine jets of water, playing horizontally below it, produce a fast moving film which carries the ore forwards towards an endless felt belt, working across the central partition. The pyrrhotite and gangue material fall through this film to the bottom of the tank; while the chalcopyrite, floating on the film, is carried to the belt, which lifts it across the partition and drops it into the water on the other side. The chalcopyrite, being now wet, sinks to the bottom. Spigots discharge both heads and tails from the bottom of the machine. The heads are then dried and bagged for shipment to the smelter. The process appears to be best explained as a surface tension phenomenon, the pyrrhotite and gangue minerals being at once wetted and sinking, while the chalcopyrite is not wetted and so floats and is carried forward to the belt (Perkins 1916:198–199).

The Wood process ultimately proved too unreliable to justify large-scale installation at Pike Hill, and the Pike Hill Mines Co. began experiments with conventional oil froth flotation beginning in the summer of 1916. The development of froth flotation, first used commercially in Australia in 1905, is considered the birth of the modern mining industry. The process relies on the attraction of fine particles of metallic ore to chemically treated bubbles. The process involves tumbling metallic ore in a series of rod and ball mills, large electrically driven rotating drums filled with steel rods or balls to grind the ore into talcum powder consistency. The fine ore is then added to tubs filled with water and special flotation reagents, and agitated with rising bubbles and motorized paddles. The metallic ore particles are attracted to the floating bubbles that rise to the top and are skimmed off, and the fine waste rock mill tailings are removed from the bottom of the flotation chambers. The first commercial froth flotation mill in the United States was installed at the Black Rock Mine at Butte, MT, in 1912. In 1914, three years before the Pike Hill Mines Company set up the Pike Hill Ore Mill, there were 42 flotation mills operating in the U.S. (Bunyak 1998:29–30).

Froth flotation was applied at all three Orange County copper mines during the early twentieth century. In 1917, at the Ely Mine, Ely-Copperfield Associates built a flotation plant designed to handle 200–250 tons per day and to extract 90 to 95 percent of the copper in ore from the extensive dump piles. The mill produced 3,600 lbs of copper during its 10 month 1918 campaign. In 1917 the General Engineering Company set up a flotation system at the Elizabeth Mine for August Heckscher's Vermont Copper Corporation. Flotation experiments continued there under the American Metals Company in 1925 and the National Copper Corporation in 1929–1930. The Elizabeth Mine's most productive run, between 1943 and 1958, relied on a flotation plant to upgrade the ore concentrate (Abbott GMC 1964:281–287, 306–307; Jacobs 1918:143–145).

At Pike Hill, extensive alterations to the magnetic separation mill building for the new 100 ton per day capacity flotation mill began in April 1917 and were completed following September or October, when concentrates production began. In keeping with the new industrial power applications of the early twentieth century, this entire operation was powered by electricity. The plant was powered by electricity from a 13,200 volt Eastern Vermont Public Utilities Corp line from Groton, VT, 15 miles away, and stepped down to 440 volts at the mine (Abbott *GMC* 1964:306–307).

In 1918, E.C Jacobs of the University of Vermont reported on "Progress in Copper Mining and Milling" in the *Report of the State Geologist* (Jacobs 1918:145–147). Jacobs's essay included a description of the Pike Hill Mines Co. mill process and a diagram of the concentrating mill flowsheet (Figure 6-7). The majority of this equipment is illustrated in the Ely Mine and Elizabeth Mine reports (Cherau et al. 2003, 2005). Mined ore, or ore from the dump piles, was trammed to an 800 ton rough ore bin on a waste rock embankment and elevated wood trestle. The ore was crushed in a 9-x-15-inch Sturtevant jaw crusher. The latter type of crusher consists of two vertical opposed steel plates, one fixed and one moving, that form a jaw through which material passes via gravity and is crushed to the size of the smallest aperture (Taggart 1945:4/1–20). The crushed ore was stored in a timber framed 100 ton capacity storage bin. The ore was then fed to a Hardinge-type conical ball mill, a 6 ft long by 22-inch diameter rotating horizontal steel cylinder filled with water and several tons of chrome steel balls, belt-driven by an electric motor. The tumbling action of the balls ground the ore to #60 mesh fineness (Taggart 1945:5/1–10).

The ground ore and water slurry was fed to two Richards 2-pocket hydraulic classifiers, a shallow rectangular trough with two "sorting columns," or conical tubs, into which the ore pulp is fed at the top. Water is introduced at the apex of the tub at the bottom, and the rising column of water sorts the particles, the large ones sink to the spigot at the bottom, and the smaller ones are skimmed off the overflow at the top into the next tub, where further sorting takes place (Hofman 1913:613). Figure 6-8 illustrates a typical Richards classifier.

The coarse spigot product was pumped back to the Hardinge ball mill for regrinding. The overflow product was pumped to a Mineral Separation Company 10-compartment flotation cell. These cells operated on the flotation principle described above, separating the copper-bearing chalcopyrite from the pyrrhotite and rock particles. The flotation cells produced "heads," which consisted of chalcopyrite-rich concentrates; "middlings," a mix of chalcopyrite, pyrrhotite and tailings; and "tails," the powdered waste rock. The heads from the flotation cells were fed to a settling tank, possibly a small Dorr thickener, a cylindrical tank with a rotating arm that accelerated the sedimentation and flocculation of the chalcopyrite grains suspended in the slime, reducing its amount of excess water (Taggart 1945:15/1–15). The heads were then dried dewatered in a 6-x-4-ft Oliver continuous filter, a tub containing a perforated horizontal drum that rotated on a horizontal axis through the slime, which was sucked onto the drum by vacuum,

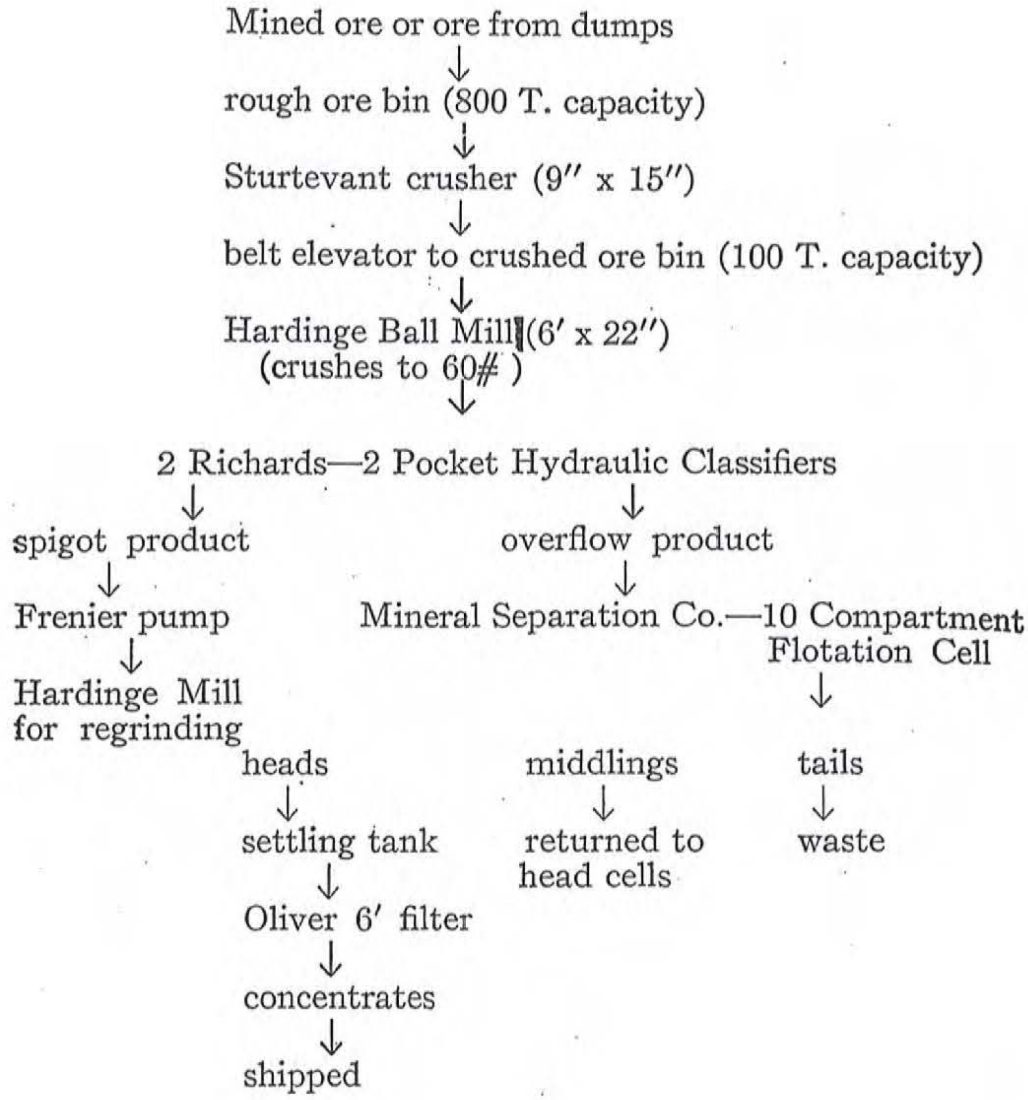

Figure 6-7. Pike Hill Mines Co. Flotation Mill flowsheet (source: Jacobs 1918:144-145).

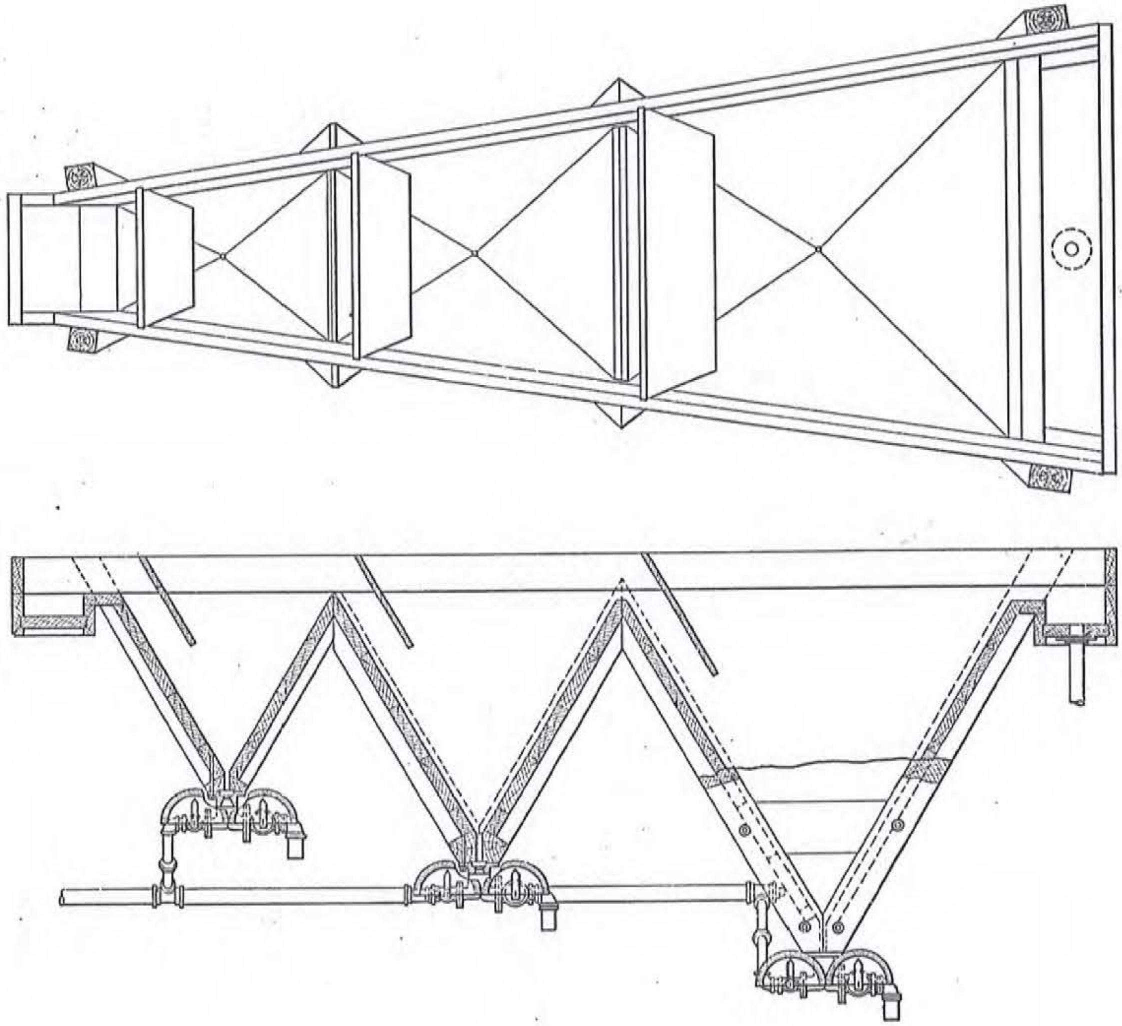

Figure 6-8. Technical illustration of a Richards classifier (source: Hofman 1913: 613).

drawing out the water, and leaving a cake that was scraped off (Taggart 1945:16/1–19). The concentrated chalcopyrite cake was then packed and shipped. The middlings were recycled into the head cells. The tails were pumped in a slurry in a launder trough or pipe supported on a wood post trestle to the tailings pile across the access road to the east (Jacobs 1918:145–146).

In 1918, this mill treated 100 tons of ore per 24 hour period. Flotation reagents consisted of pine oil alone, introduced to the head cell. The incoming ore averaged 2.5 percent copper, with a maximum of 3.75 percent. About 90 percent of the copper was being recovered. The shipped concentrates averaged between 18 and 20 percent copper, with the richest showing 24.28 percent. They also carried 1.5 oz silver per ton and a trace of gold. The mill required only 1 man to run it below the crusher level (Jacobs 1918:146).

According to Harry G. Hunter, shipments of manually upgraded ore for offsite refining from October 1915 to January 1916 consisted of 210 tons averaging 10 percent copper and 1 ounce of silver per ton. Production for the mill calculated after offsite refining in New York in 1916 was 281,271 lbs of copper and 1,675 oz of silver, extracted with a combination of the old magnetic separation equipment and the Wood flotation process experiments. In 1917 production was 51,090 lbs of copper and 216 oz of silver. Production for the first half of 1918 was 185,206 lbs of copper and 776 oz of silver. The maximum rate of production was attained in August 1918, when the mill produced 412,111 lbs of concentrates containing 69,810 lbs of copper (Jacobs 1918:147). According to Perkins, writing in 1942, production for the mine "in 1918" calculated after offsite refining in New York was 509,654 lbs of copper, and 2,056 ounces of silver (Perkins 1942:12). This appears to be a total for the 1916–1918 operations, rather than a for the year 1918. Mining and milling operations ceased in the spring of 1919 because of falling copper prices after World War I.

The flotation process at Pike Hill produced tailings containing finely ground particles of pyrrhotite and quartz-mica schist. This material weathers to a characteristic pale yellow color on its upper surface. The light yellow, more finely textured appearance of the flotation tailings makes them easy to distinguish from the coarser, gray magnetic separation tailings that appear beneath them in places. The flotation tailings were deposited in broad fans in the areas east of the Ore Mill and its adjacent access road. They were transported in a water slurry in a pipe or wood trough (launder). There is some evidence that they were impounded in some sort of timber structure or conventional tailings drainage impoundment reinforced with timbers. The visible volume of flotation tailings suggests that some of this material may have eroded and washed into the wooded area below the Ore Mill. It is possible that the tailings fire discovered in the early 1980s southeast of the mill may have involved the pyrrhotite in the flotation tailings, which is known to spontaneously combust.

Power Production

During the nineteenth century, mechanical power for hoisting ore from the Eureka Mine shafts was generated by draught animals, and for the Union Mine shaft by a stationary steam engine with boilers fired by cordwood. There was little, if any mechanization of the ore processing. At the beginning of the twentieth century, advances in power generation and transmission were incorporated to power new types of hoists and also new ore processing machinery. The early twentieth-century power generation equipment at Pike Hill included machinery for which no evidence has been found at the Elizabeth or Ely mines: the gas producer/Otto engine combination to drive dynamos for electricity, for magnetic separation, lighting, and pumps; and the gasoline-powered mine hoist. World War I operations moved toward individual electric motors on individual pieces of equipment.

Gas Producer/Otto Engine

In 1905 Harry G. Hunter began installation of the magnetic separation equipment in the Knox & Allen Ore Mill. The Wetherill magnetic separators required a dedicated source of reliable, consistent direct-current electricity. The cost of transporting wood or coal to the mine and the seasonal scarcity of water made continuing the use of a boiler-fed, steam engine to power a dynamo impractical. In the winter of 1907 Hunter replaced the steam-powered system with one consisting of the combination of a gas producer and internal combustion engine. The gas producer is an upright cylindrical furnace in which air, or air and steam, are forced through a thick bed of incandescent burning coal (Figure 6-9). The oxygen combines with the carbon to form carbon dioxide, which is further reduced to carbon monoxide, which escapes with hydrogen and nitrogen resulting from the action of the steam on the red hot coal. The resulting mixed carbon monoxide/hydrogen component is flammable, but the approximately 50 percent nitrogen content results in a gas with relatively low caloric value. This gas is then piped to an "Otto" engine, a 4-stroke internal combustion engine invented in 1876 by Dr. Nikolaus August Otto (Marks and McDewell 1921a:7, 64–65). The Pike Hill Mining Co. Ore Mill contained one gas producer and two Otto engines (a No. 9 and a No. 10, of approximately 45 hp each), with their drive shafts connected to electric generating dynamos. This equipment was housed in an extension at the east side of the Ore Mill, and provided a steady reliable source of electricity for the magnetic separators as well as other motors and lights. This was the only gas producer/Otto engine power installation documented in the Vermont Copper Belt. In 1917 this electrical generating system was replaced by the 13,200 volt Eastern Vermont Public Utilities Corp transmission line from Groton, VT.

Gasoline Hoist

The Union Mine Hoist House contained a conventional steam-powered mine hoist, consisting of a cordwood-fired steam boiler providing steam for a horizontal cylinder steam engine, with its crank shaft connected to a large metal winding drum for the hoisting cable. Interpretation of the remaining machinery bases and pins support this (see Chapter 7). This type of hoist was typical for the period of operation, and similar systems were employed at the Ely and Elizabeth mines. No manufacturer or specification records exist for this machinery.

The Cuprum Shaft area within the Eureka Mine subsite contains evidence for use of a small "petroleum hoist." These gasoline-powered mine hoists were initially developed in the 1890s for Western U.S. mines where water and fuel for conventional steam-powered hoists was scarce, and particularly at small mines where capital investments in water and fuel were impractical. They were smaller than steam hoists, and their concentrated liquid fuel was easier to transport. Their performance was limited. They could only hoist at a speed of 300 to 400 ft per minute, could not raise more than 4,500 lbs, and could not work shafts more than 1,000 ft deep. Early units could not stop or start under load or be reversed, and had to be run continuously. However by about 1910 technology and throttle, brake, and clutch design improved, and they were increasingly embraced at small and/or remote operations (Twitty 2002:173–176). During the 1910s and 1920s, mining engineers had devised a variety of types and sizes of electric hoists (Twitty 2002:278). The Eureka Mine may have used a small electric hoist or hoists during the World War I era, either at the surface or underground. The pattern of the machinery pins at the Cuprum Shaft (see Figure 7-27) appears to match an illustration of a Fairbanks-Morse petroleum hoist (Figure 6-10). Machinery bases for small electric hoists are less well-documented. This machinery base is the only evidence of this particular type of hoisting machinery documented in the Vermont Copper Belt.

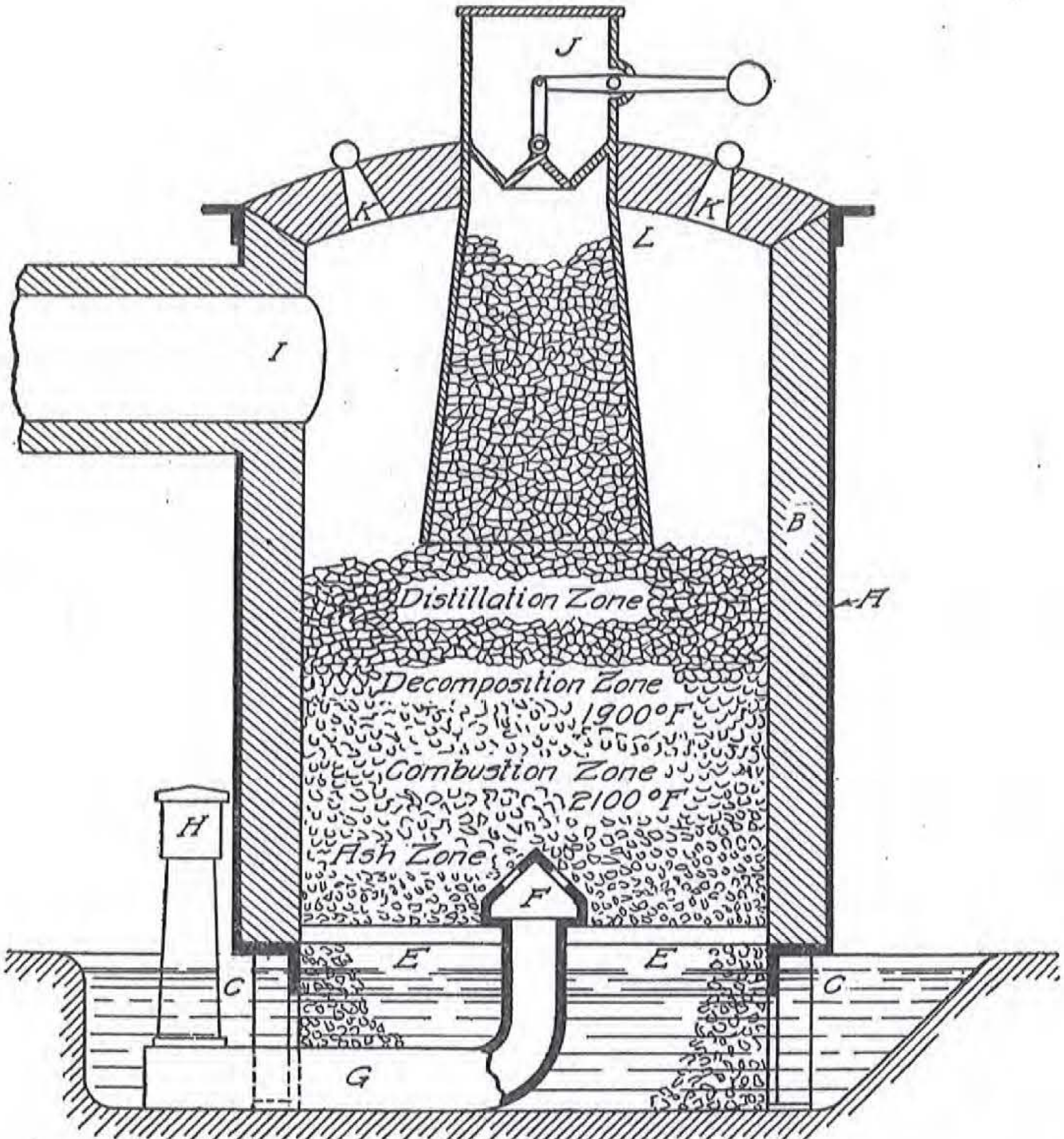

Figure 6-9. Technical illustration, cross section of a gas producer (source: Marks and McDewell 1921b:5).

Fairbanks-Morse
Horizontal Cylinder
(Right)
1890s-1910s

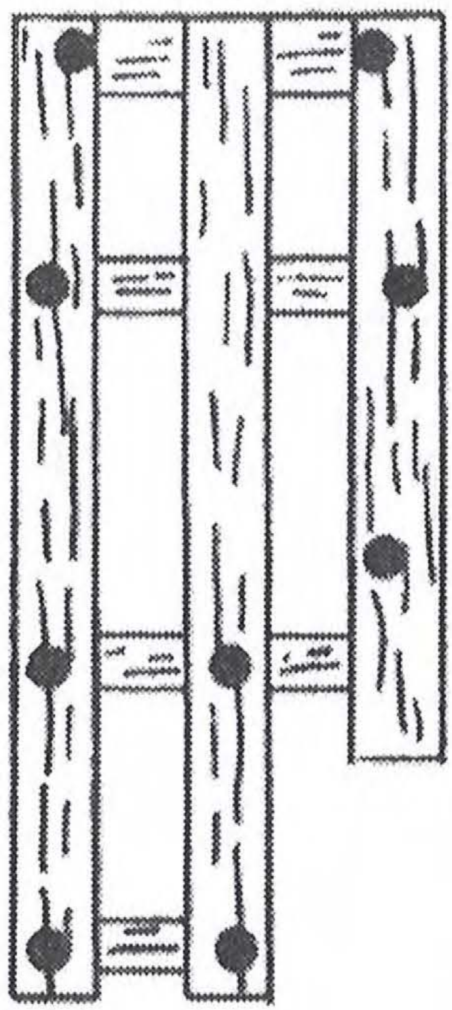

Figure 6-10. Diagram of a Fairbanks-Morse petroleum hoist footing and bolt pattern (source: Twitty 2002:177).

CHAPTER SEVEN

INDUSTRIAL RESOURCES – RESULTS AND INTERPRETATIONS

This chapter describes the existing conditions of the Pike Hill Mines Site's industrial resources. It begins with a discussion of the overall spatial arrangement of the four industrial subsites in relation to the domestic subsites (see Chapter 8), as well as several isolated industrial features ("isolates"), and the current mine site transportation routes. Detailed descriptions of the visible resources identified within the industrial subsites and isolates follow. These descriptions include information about the location, configuration, size, appearance, materials, and condition of the resources.

Industrial resources at the Pike Hill Mines Site include the landscape and structural remains of mining and ore processing areas and associated materials handling and waste disposal features. There are no standing structures related to industrial resources within or adjacent to the preliminary project APE. Documentary information pertaining to the historic Pike Hill Mines industrial operations is limited to a few late-nineteenth-century photographs and brief, sometimes confusing descriptions of the mining process in historical sources (see Chapter 5 discussion). There are no available historical maps that detail the Pike Hill Mines industrial structures other than a 1944 U.S. Geological Survey map that shows the buildings standing at that time (see Figure 5-14). From the historical written sources, it is known that there were two mining companies with adjacent but separate operations right up until the last few years of operations during World War I, when they came under common ownership.

The historic and archaeological mapping and testing program identified four industrial archaeological subsites within the project APE: Eureka Mine, Union Mine, Smith Mine, and Prospect Trenches, as well as several isolates (see Appendix B and 9-1). Each visible feature, such as a foundation, wall, prospect trench, shaft, open cut, waste rock pile, etc. identified during the fieldwork/mapping component of the project was assigned a survey number. The numbers assigned to these features were then, where possible, cross-referenced with the historical photographs and USGS 1944 map of the site (Figures 7-1 through 7-7; see Figure 5-14). The features are discussed by number and the text frequently refers to the ca. 1880 and ca. 1907–1919 historical images to more fully describe and interpret the industrial remains. Most of the visible resources correspond with the limited historical documentary record. This chapter also includes a discussion of the several industrial isolates located in the northwestern part of the APE, outside the industrial and domestic subsites.

Site Layout and Spatial Arrangement

The Pike Hill Mines Site straddles the summit of Pike Hill, west and southwest of Richardson Road. The terrain is irregular and moderately steep, varying in elevation from 1,963 feet above sea level just east-southeast of the Cuprum Open Cut, to 1,462 feet above sea level just south of the Smith Mine. The site is spatially complex, and frequent reference to Appendix B is key to understanding the site layout. The subsites and isolates are oriented on an essentially north-south axis, in an area measuring approximately

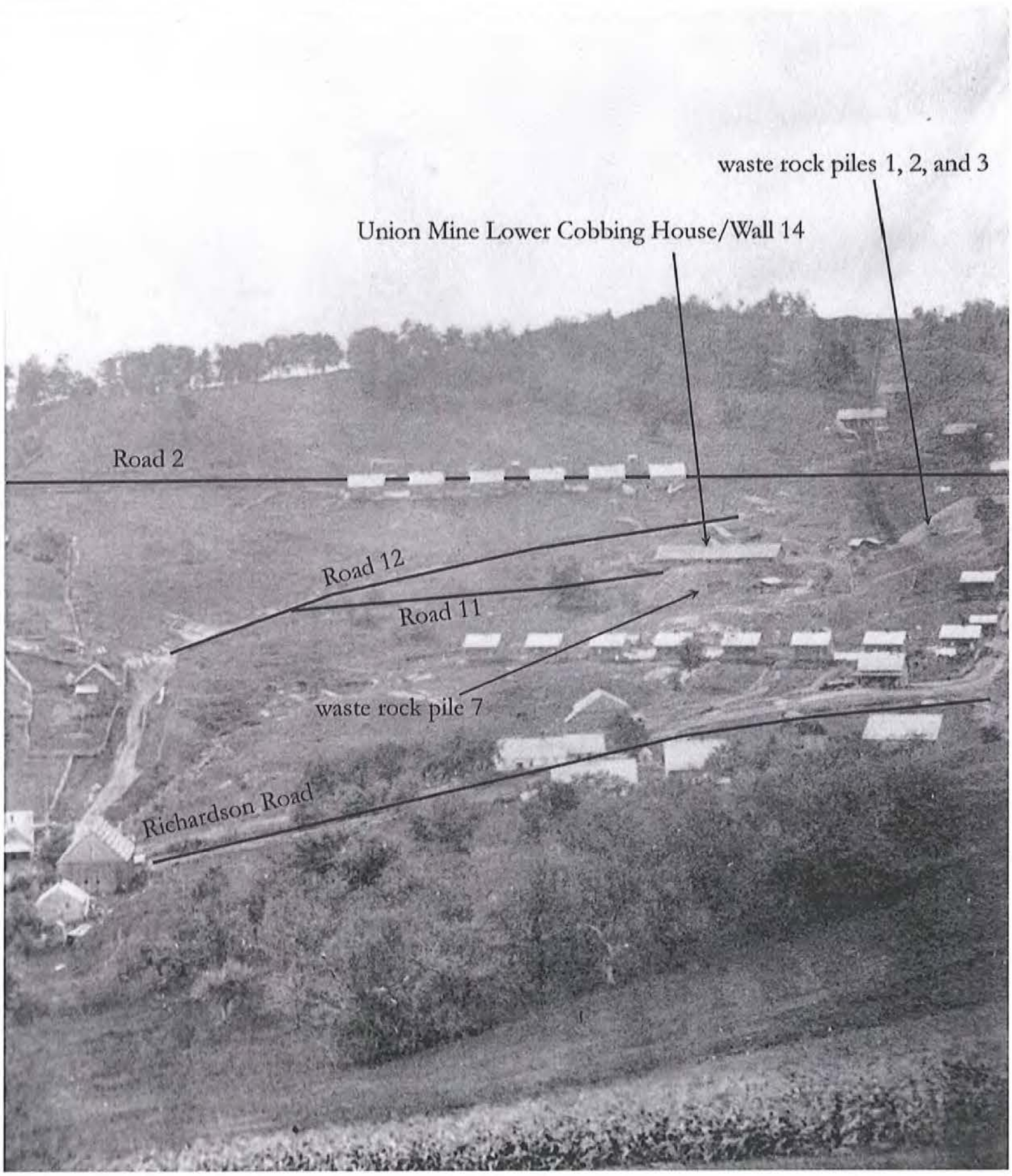

Figure 7-1. Ca. 1880 photograph of the Union Copper Mining Co. village area, showing mine road system on the northeast slope of Pike Hill, looking east (source: http:// www.uvm.edu/landscape//).

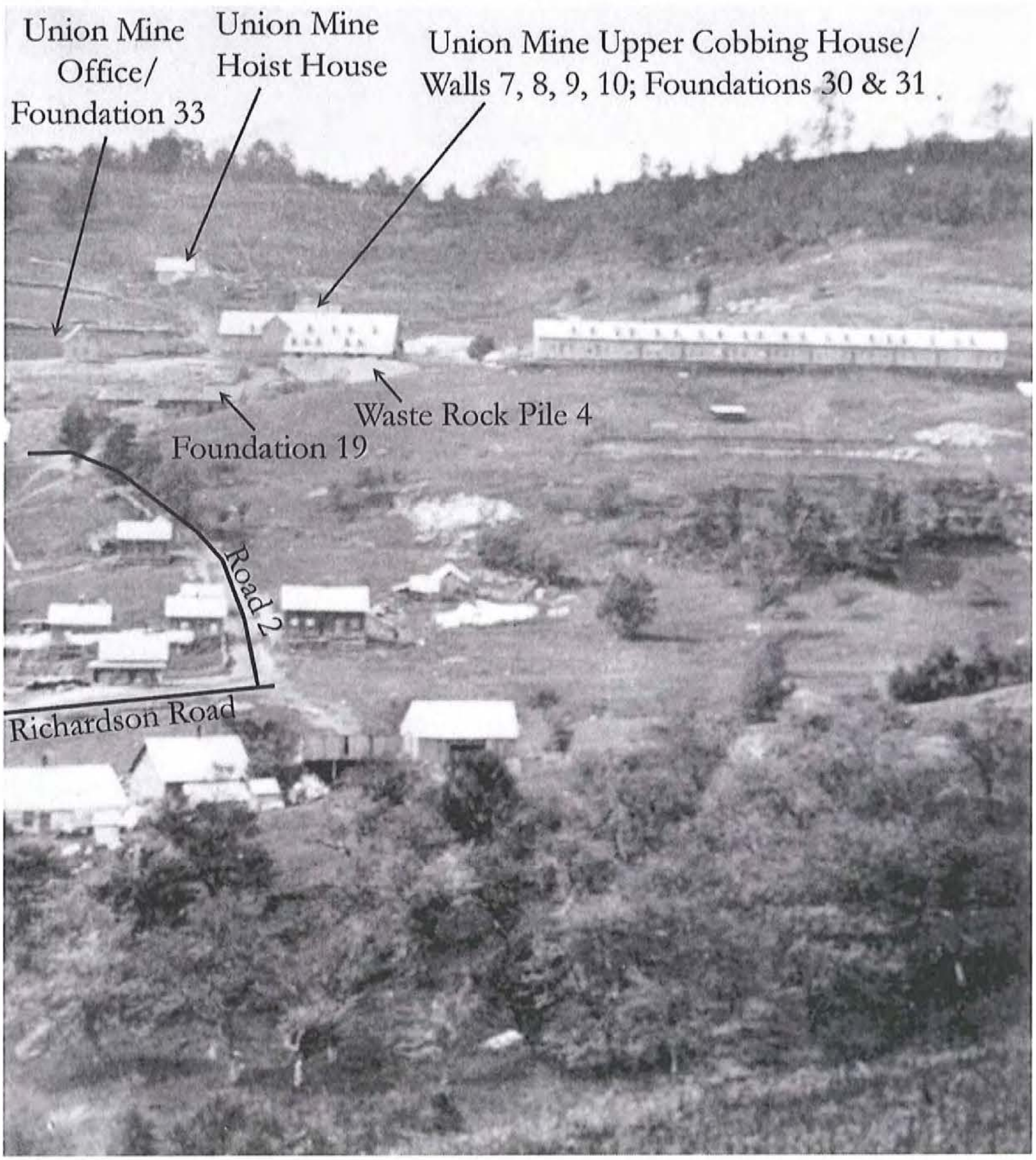

Figure 7-2. Ca. 1880 photograph of the Union Copper Mining village area, showing mine roads and industrial features, looking east (source: http://www.uvm.edu/landscape//).

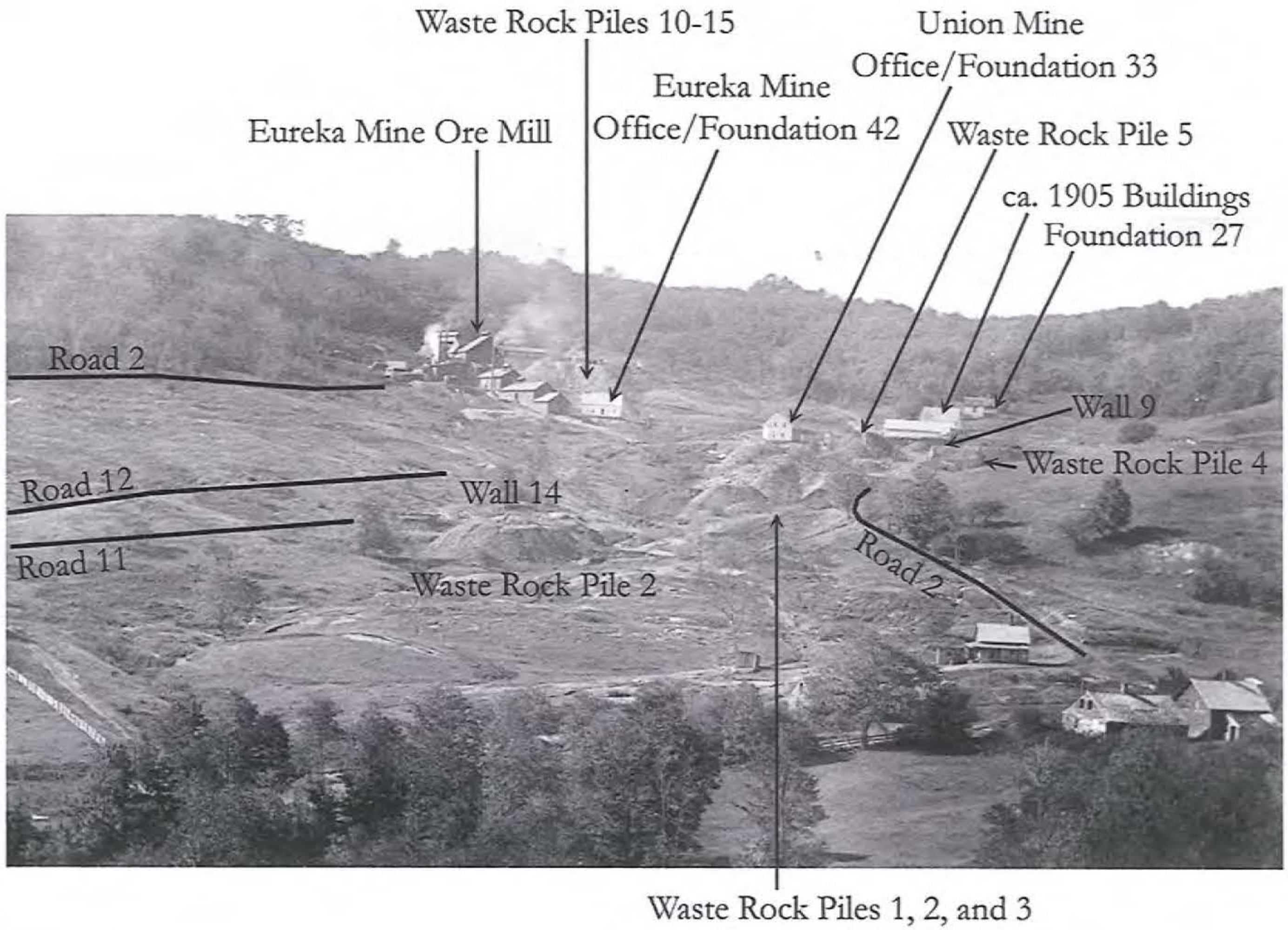

Figure 7-3. Ca. 1907 photograph of the Pike Hill Mines Co., showing mine roads and industrial features looking east (source: http://www.uvm.edu/landscape//).

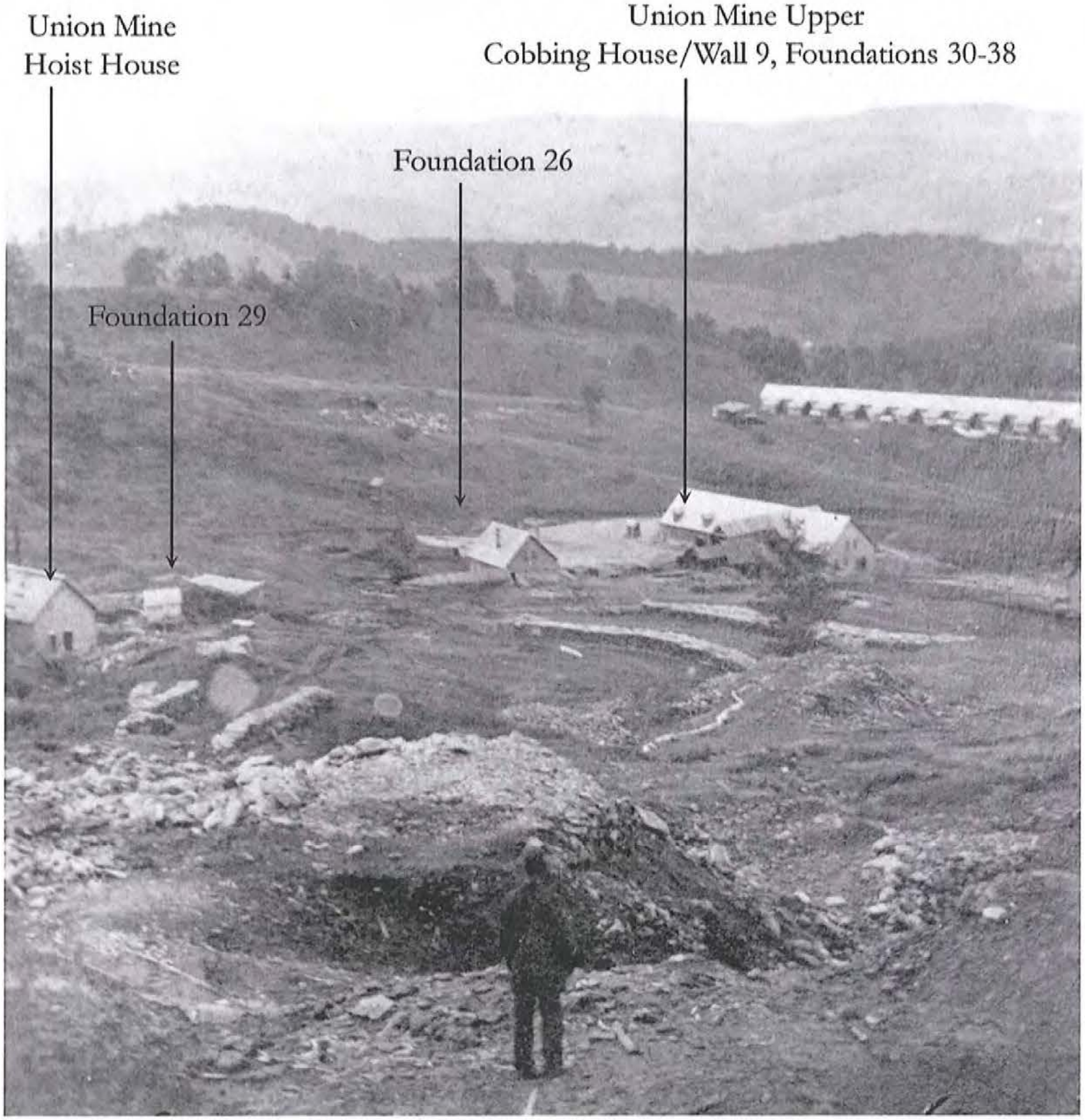

Figure 7-4. Ca. 1880 photograph of the Union Mine showing industrial features, looking northeast (source: http://www.uvm.edu/landscape//).

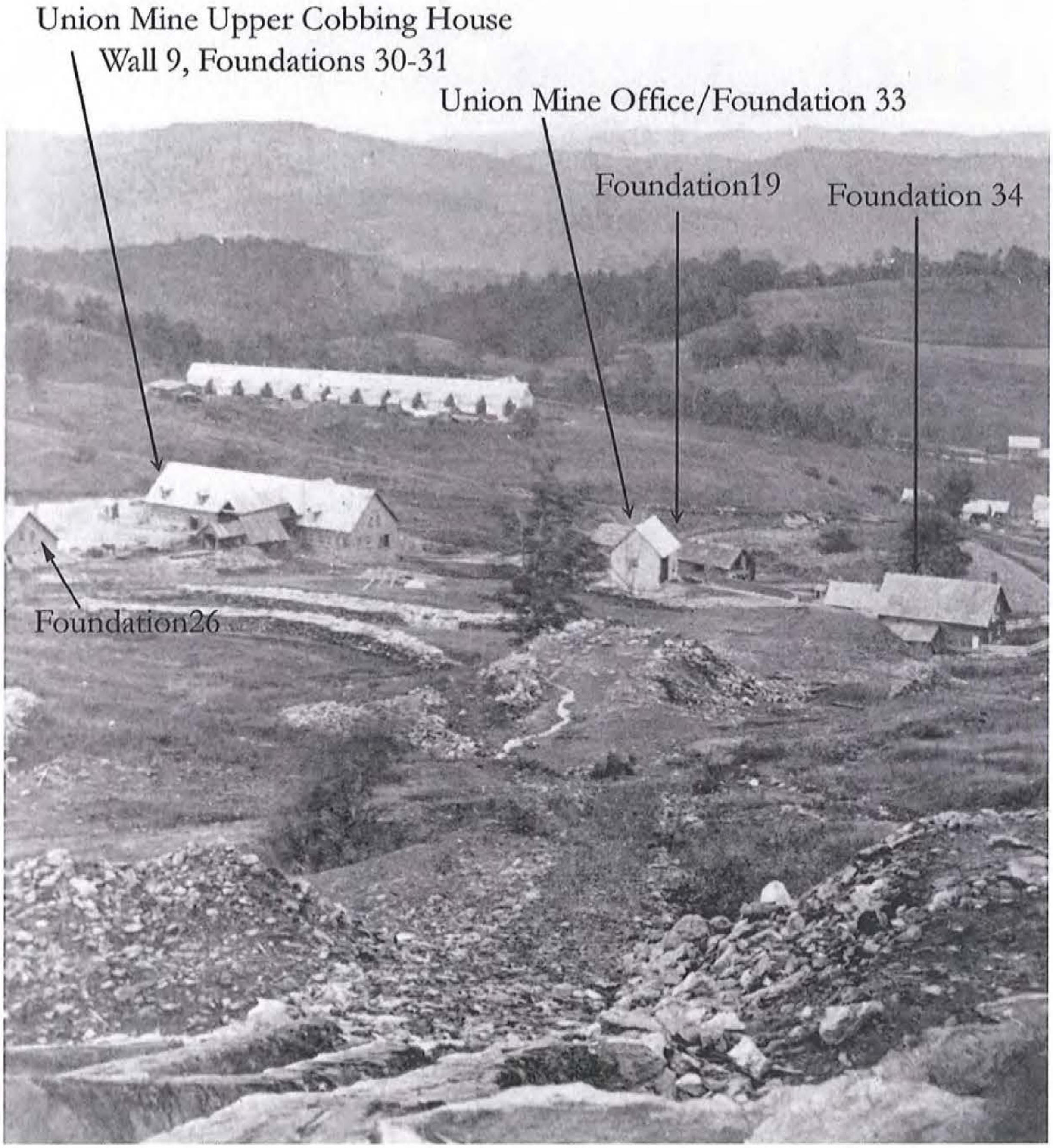

Figure 7-5. Ca. 1880 photograph of the Union Mine showing industrial features, looking northeast (source: http://www.uvm.edu/landscape//).

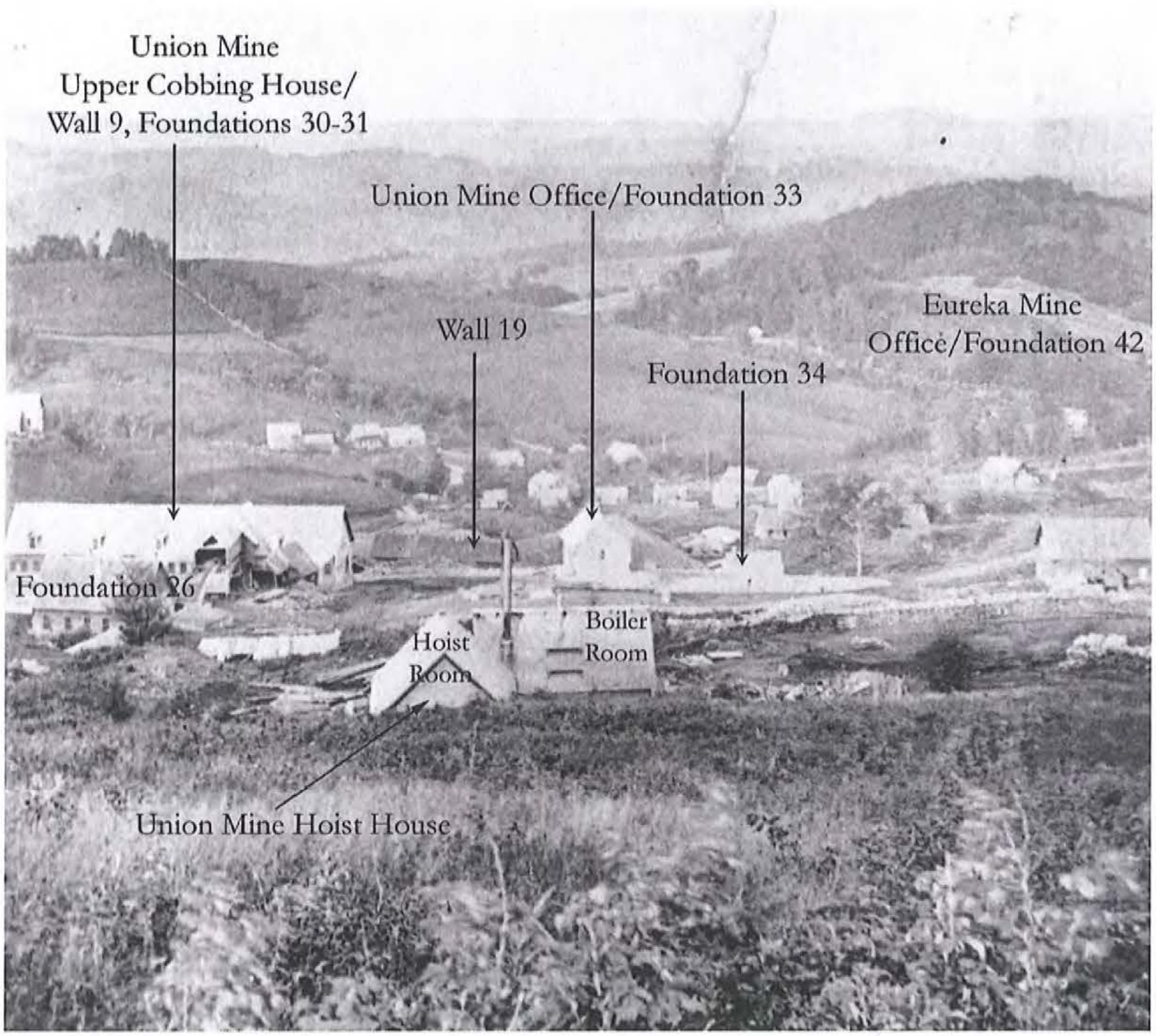

Figure 7-6. Ca. 1880 photograph of the Union Mine, showing industrial features looking east (source: http://www.uvm.edu/landscape//).

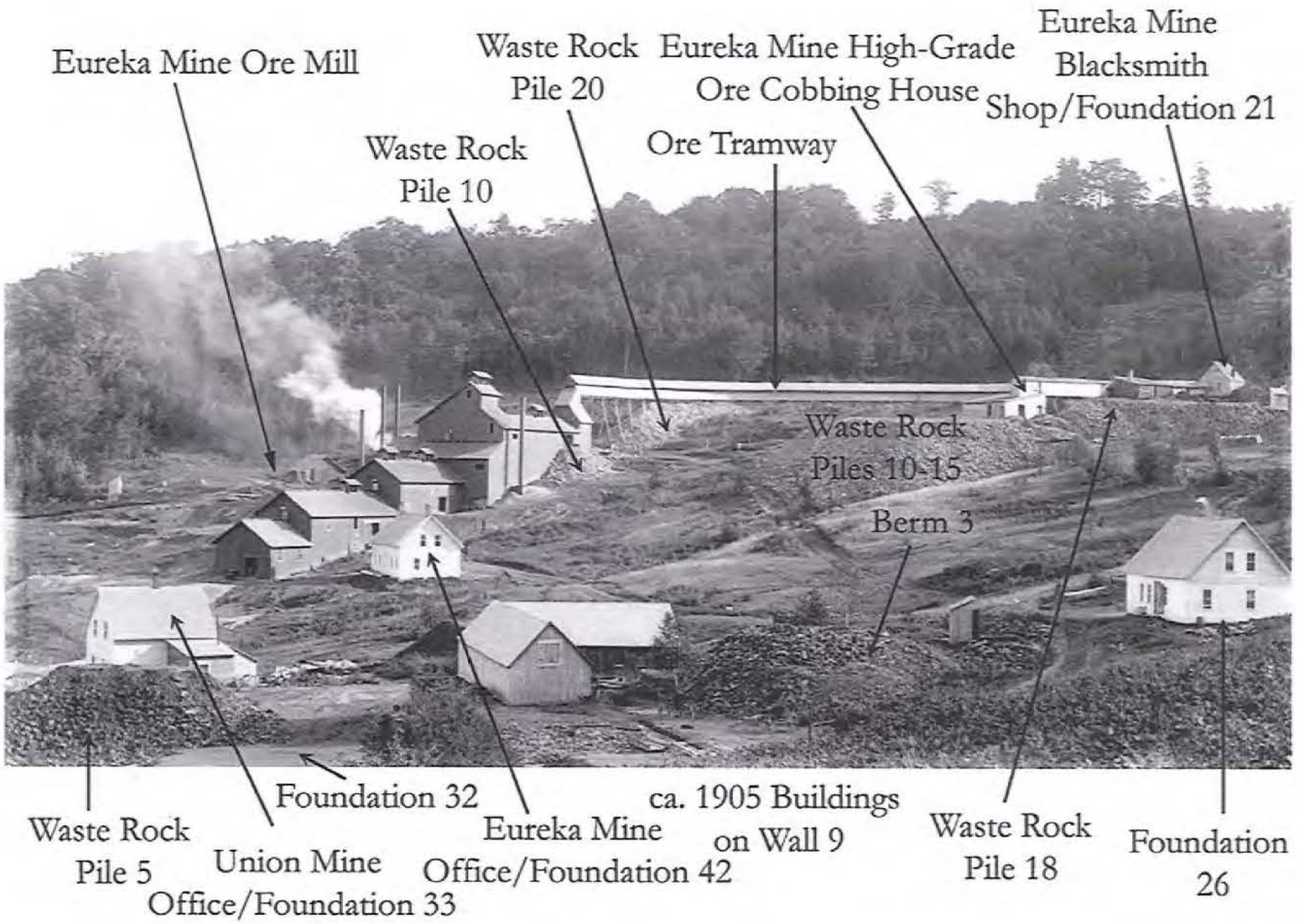

Figure 7-7. Ca. 1900s photograph of the Ore Mill, Pike Hill Mines Co. showing industrial features, looking southeast (source: http:// www.uvm.edu/landscape//).

4,800 feet long north-south, by approximately 2,000 feet wide east-west. The subsites include, from south to north, the Smith Mine Subsite on the south slope of Pike Hill (5.5 acres); the Prospect Trenches Subsite, stretching north to the summit of Pike Hill (38.2 acres); the Eureka Mine Subsite extending from the summit down the southeast side of Pike Hill (14.9 acres); the Upper Row ([2.1 acres] domestic subsite—see Chapter 8,) Union Mine Subsite (14.5 acres), New Row ([5.9 acres] domestic subsite—see Chapter 8), Lower Row ([6.2 acres] domestic subsite—see Chapter 8), all on the northeast flank of Pike Hill. The six industrial isolate sites are located in an approximately 1,500 foot long arc northwest of the Union Mine and New Row subsites. These subsite divisions separate the landscape into discrete areas of types of industrial and domestic activity. The Union and Eureka industrial subsites are large areas that include a range of resources associated with ore mining and processing activities and associated features. The Smith Mine site is similar, but smaller with a more limited variety of mining resources. The Prospect Trenches Subsite is large, but only includes excavation features associated with exploration for additional orebodies. The isolates include a range of activities including exploration for ore, and obtaining building stone and water for the mine. Transportation roadway systems, discussed immediately below, overlay the Pike Hill Mines Site and cross subsite boundaries.

Current Road System

Access to the Pike Hill Mines Site is via two unpaved historic roads leading southwest from Richardson Road, which runs in a generally northwest-southeast direction, northeast of the site. Access to the mine site from the south, and direct access to the Smith Mine Subsite and Prospect Trenches Subsite, is via Coppermine Road, which extends southwest off Richardson Road, just northwest of its intersection with Pike Hill Road. Coppermine Road trends west, then south, and meets another road at a T-intersection. Proceeding west from that intersection, the road comes to a four-way intersection. The road to the north (Road 2) winds around the east side of Pike Hill to the Upper Row/Eureka Mine/Union Mine subsites. The road to the west (Road 17) crosses the south flank of Pike Hill, curving north, west, and back south to a dead end at the Smith Mine Subsite. Access to the Eureka and Union mines subsites, as well as the domestic and isolate subsites, is via a steep, rocky, unpaved road (Road 2) on the southwest side of Richardson Road, approximately 1 mile northwest of its intersection with Pike Hill Road. This road leads southwest through the Lower Row domestic subsite, past the New Row domestic subsite to the northwest, skirts the north edge of the Union Mine Subsite to the south, turns south through the center of the Union Mine Subsite, and turns east and proceeds through the north end of the Eureka Mine Subsite to the Upper Row domestic subsite and the road along the east side of Pike Hill to the Smith Mine.

A secondary series of historic mine access roads radiate off Road 2 to reach other parts of the Pike Hill Mines Site. These roads have all been kept open by recreational foot, bicycle, and all-terrain vehicle traffic. It is possible some roads may also be open for access for logging, however, no evidence of recent logging activity was observed. Although there are no historic maps for these mines, the majority of the extant roadway system leads through, or to, areas containing clear evidence of concentrated historic mining and/or mining support activity. These secondary historic roads are included in the descriptions of the individual subsites.

Union Mine Subsite

The Union Mine Subsite is located near the north end of the Pike Hill Mines Site, on the east flank of Pike Hill, north of the Eureka Mine Subsite, and south of the New Row and Lower Row domestic subsites. It is one of three mining-related industrial subsites, the others being the equally large Eureka Mine Subsite, and the other the smaller Smith Mine Subsite at the south end of the Pike Hill Mines Site.

The Union Mine Subsite is a 14.5 acre, approximately 1,700 foot long east-west, approximately 500 feet wide, crescent-shaped area. The subsite pinches to approximately 125 feet wide west of its center, at a roadway junction where Road 1 enters from the north, Road 3 and Road 4 extend to the west, and Road 2 enters from the northeast and curves south and back east. The area contains mine openings, machinery remains and bases, waste piles, foundations, roads, and materials handling and water collection features associated with underground mining, ore handling and processing, and associated support functions. The features are arranged downslope from west to east, following a logical sequence of mining, processing, waste disposal, and transportation as aided by gravity. The Union Mine Subsite can be divided into four discrete geographic areas from west to east: the Union Shaft/Adit Area, the Upper Cobbing House Area, the Waste Rock/Walls/Foundations Area, and Lower Cobbing House Area. The following descriptions and interpretations follow the landscape and mining features downslope from west to east.

Union Mine Shaft/Adit Area

The Union Mine Shaft/Adit Area is located at the west end of the Union Mine Subsite. It is an approximately 500 foot east-west by 400 foot north-south area located west of the narrow roadway junction area to the east. The focal features of this area are the shaft and adit from which the ore was hoisted and hauled out of the mine for processing. The shaft is located at the center of the area, and the adit is located just to the northeast.

The Union Mine Shaft/Adit Area includes a cluster of features in the area formerly within and adjacent to the hoist house, which appears in historical photos (see Figures 7-2, 7-4, 7-5, and 7-6) as an L-shaped building consisting of two gable-roofed sections (hoist room and boiler room) with a boiler chimney located near their junction. Historical views (see Figure 7-5) also show long rows of cordwood for the boiler stacked up near the building. This area also contains the inclined shaft itself and associated machinery pads and stone walls (Figure 7-8).

The bedrock topography in the shaft area was manipulated to create a T-shaped area that includes the shaft itself at the intersection of the arms of the "T," and platforms for the two sections of the hoist house extending to the west and south. The long axis of this T-shaped area measures approximately 50 feet north-south, with an approximately 35 feet leg extending to the west. The shaft is located in a pit approximately 15 feet long east-west by 6 feet wide north-south. The north, south, and west sides of the pit are walled in with schist and fieldstone blocks, with the west wall serving as a retaining wall for the hoist room. The shaft is at the east side of the pit, and consists of a vertical opening in the orebody plunging approximately 35 degrees down to the east, with hanging wall and foot wall of incompetent sulfidic schist (Figure 7-9). Immediately to the north is a second, larger, more irregular, approximately 16 foot by 16 foot, rectangular excavation on the orebody. This opening is a northward extension of an open cut that preceded sinking of the adjacent shaft, and is partially blocked by a fallen section of hanging wall.

Immediately south of the shaft is a rectangular, approximately 25 foot north-south by approximately 15 foot wide east-west, level area bounded by the shaft collar retaining wall to the north, the Open Cut 5 retaining wall to the east, and the foot of the slope to the west. This area contains an approximately 15 foot by 10 foot shallow oval depression filled with loose brick and concrete that also includes an approximately 3 foot long solid wrought-iron spike. This area corresponds with the location of the boiler room in the historical photographs (see Figure 7-6), and the brick and concrete scatter are consistent with debris remaining from demolition of a masonry boiler setting. The cordwood-fired boiler in this section of the hoist house provided steam to power the hoist cylinders on the stationary steam engine in the adjacent hoist room. Water for the boiler was drawn from a series of water collection features in the landscape above the building to the west (see below). The boiler was likely a small, horizontal, firetube-type unit consisting of a riveted sheet iron tank filled with water, and containing multiple parallel open tubes, all supported by a rectangular mortared brick base, or "setting." The hot gases from the burning wood in the firebox passed through the open tubes and out the smokestack, heating the water around them in the tank to make steam that was piped to the hoist engine cylinders.

Immediately west of the shaft compartment is an approximately 20 foot east-west, approximately 15 foot north-south flat platform for the hoist room. This platform was cut out of the bedrock ledge west of the shaft to create a level area. This rectangular area contains the in-situ remains of two machinery bases associated with the steam-powered hoist for raising and lowering miners and ore in the mine via a cable wound onto a drum. The piers are arranged in an L-shaped configuration, with one pier with a long north-south axis located immediately west of the shaft collar and another immediately to the northwest with its long axis oriented east-west (Figure 7-10). Both piers are made of mortared brick, and have vertical, threaded, 1-1/8th inch diameter wrought-iron machinery base mounting pins sticking up from the perimeter of their upper faces. The piers are deteriorated, with an area of brick scatter located between them. The location and relationship of the piers indicates that the wider one immediately west of the shaft collar supported the cable winding drum for the hoist, and the longer, narrower pier to the northwest supported the steam engine with its pair of cylinders.

The configuration of the masonry pads and patterns of threaded hoist mounting pins are consistent with those installed for a steam driven, duplex cylinder, single-drum, "second-motion" (gear drive), band-brake hoist apparatus. This type of hoist was the preferred production-class hoist system favored by smaller mining companies with deeper shafts for its low cost, ease of installation and mechanical advantage of small steam cylinders. This machine allowed miners to raise more ore in less time than animal-powered, horse whim-type hoists. Installation and operation of this type of hoist required the capital and knowledgeable personnel of an organized mining company. The single drum, geared, duplex steam hoist consisted of a cable drum over the shaft, two steam cylinders next to the drum, reduction gears, a clutch, brake mechanism, and throttle. Steam was provided by a boiler; in the case of the Union Mine, fired by cordwood. This type of hoist met the needs of smaller, modestly capitalized mines, but was slower and less fuel-efficient than more expensive direct drive, double-drum units that were preferred for mines over 3,000 ft deep. At the Union Mine, the configuration of the machinery bases indicates that the paired steam cylinders were offset on a single pad to the north. Figure 7-11 illustrates this type of offset cylinder steam hoist. This was a less conventional configuration; the cylinders were more commonly arranged with one flanking each side of the drum (Twitty 2002:164–165, 195–210).

Approximately 30 feet south of the shaft opening is a square, 9 foot by 9 foot, flat stone platform. Approximately 27 feet east of the shaft opening, above the west wall of Open Cut 5, is Foundation 29, a rectangular, 14 foot by 7 foot, mortared schist block structure. The building associated with this foundation appears to be shown in 5-7. No records associated with the history or function of the platform or Foundation 29 was located during archival research. Two wrought-iron anchor pins were located north and northeast of the shaft opening. These pins are likely guy wire anchors for the sheet metal smokestack for the boiler room.

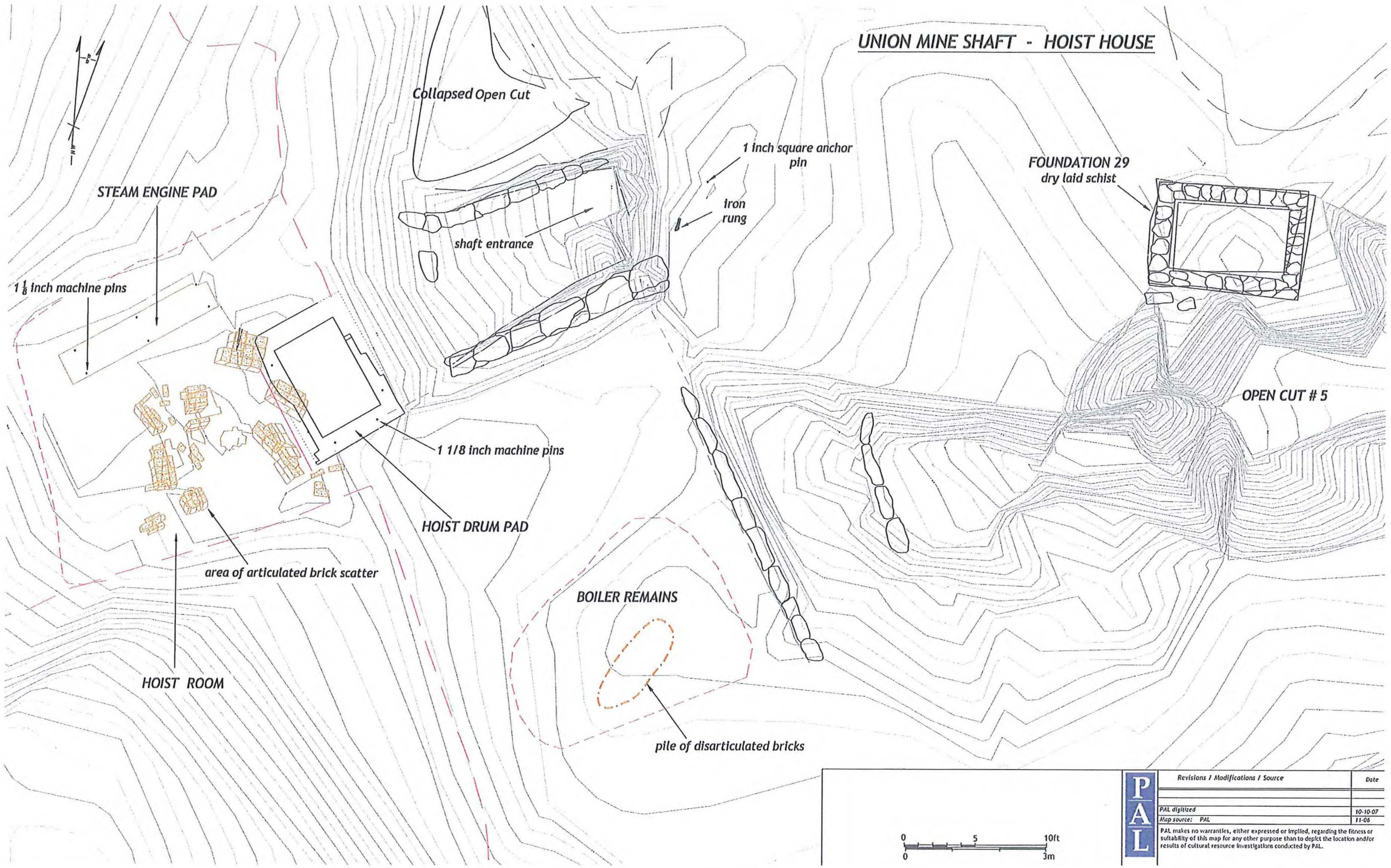

Figure 7-8. Detail plan of Union Mine Shaft area.

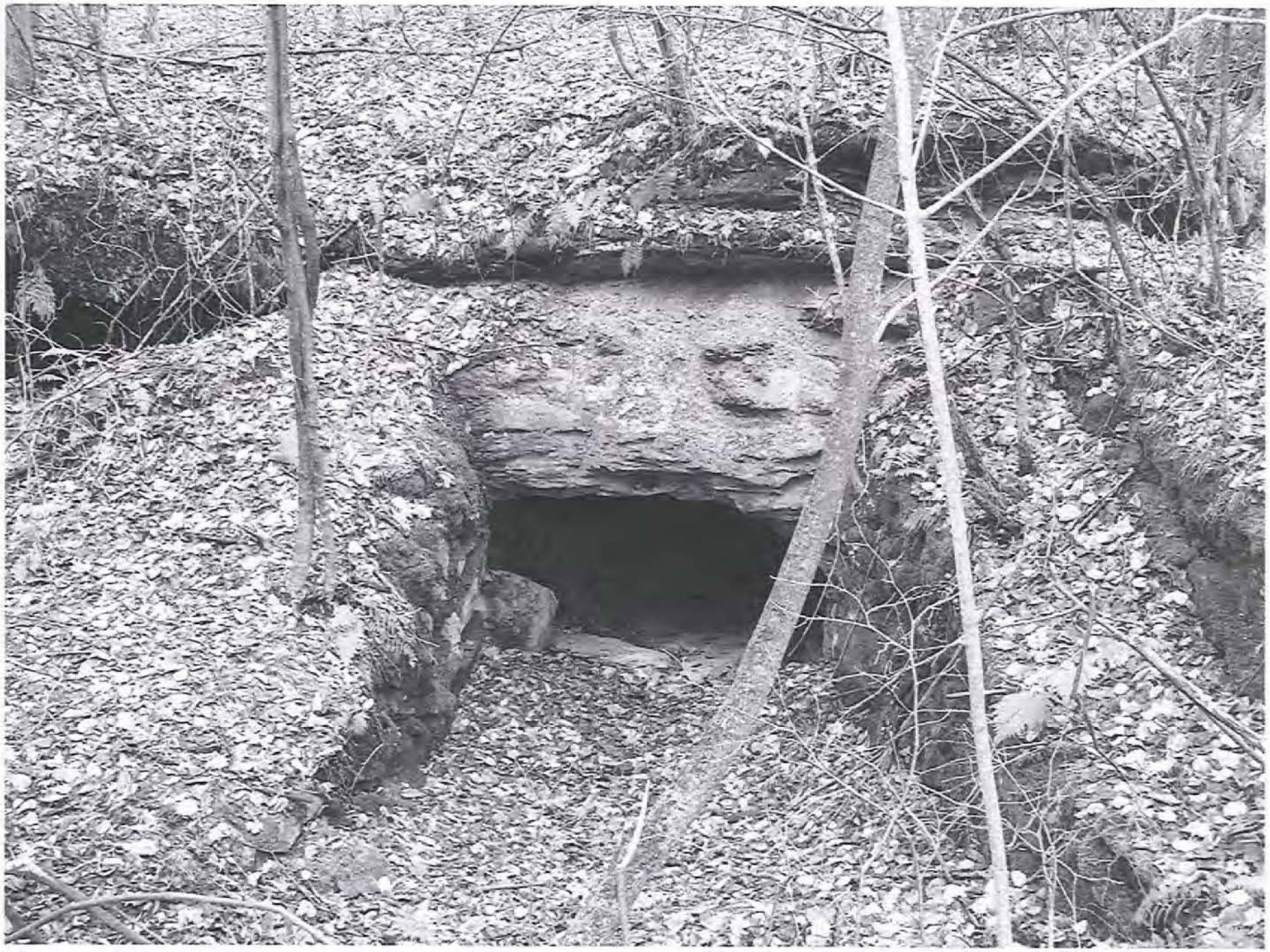

Figure 7-9. Current photograph of Union Mine shaft, view looking northeast.

Figure 7-10. Current photograph of Union Mine hoist drum pier remains, view looking northeast.

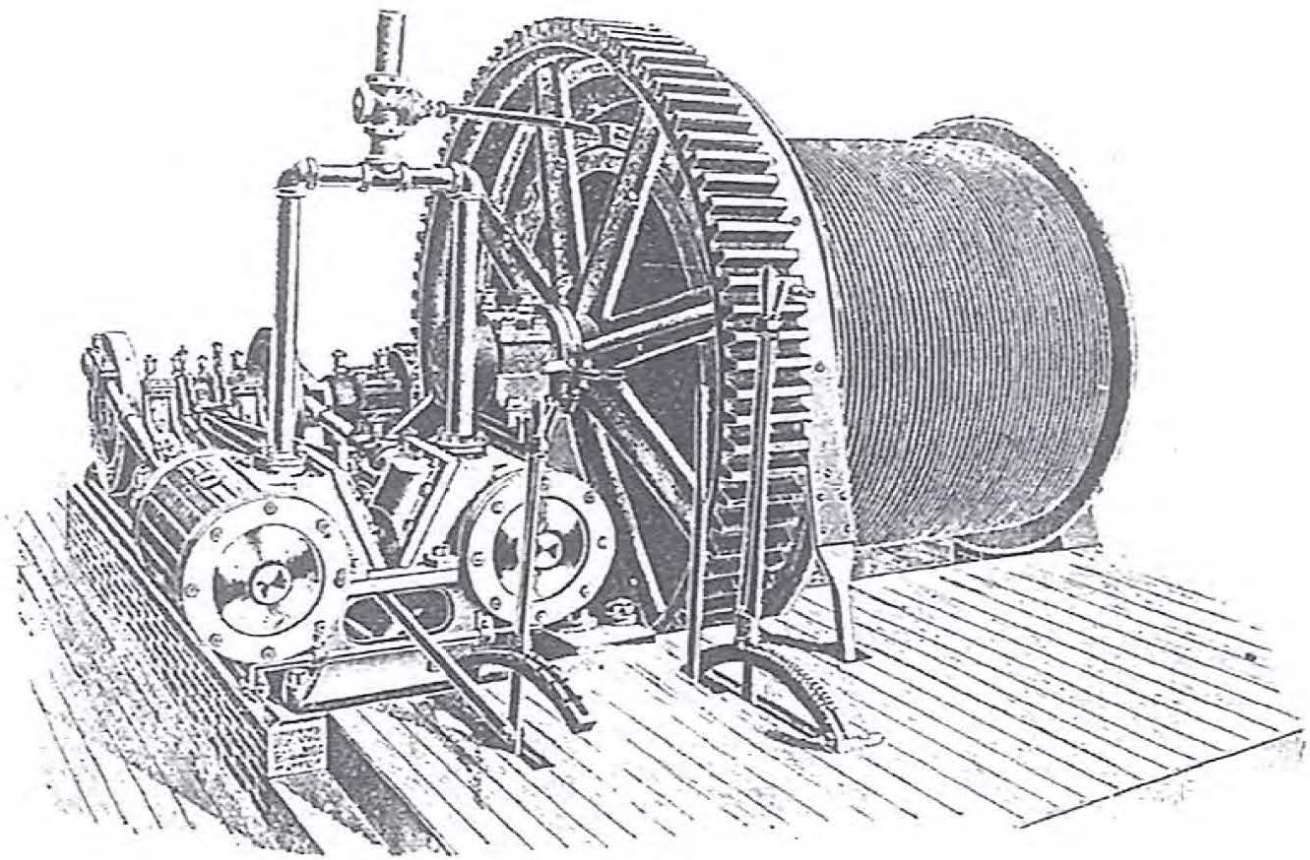

Figure 7-11. Technical Illustration of offset cylinder steam hoist (source: Twitty 2002:165).

Open Cut 5 is located immediately east of the remains of the boiler room section of the hoist house (Figure 7-12). It is an approximately 140 foot long, east-west oriented, vertical cut in bedrock averaging 15 feet wide and 20 feet deep. The rock walls appear more competent than the schist found in most of the other open cuts, and there is little evidence of sulfide mineralization for most of its length, with the exception of some limited turquoise-blue copper mineral staining. The cut intersects an earlier open cut or crosscut tunnel at the west end, and openings on both sides of the cut in that location are partially blocked by collapsed hanging wall. The west end of the cut is steep and benched with two benches held back by a pair of transverse fieldstone retaining walls. The history and function of this open cut are unclear. Some historical accounts noted that there were two adits at the Union Mine. This open cut may be an early adit that was later daylighted by removing its roof, however, it appears to be at too shallow a depth in relation to the surface to make sense as an adit, and may have simply been a haulage cut serving the open cut at its west end prior to development of the longer, deeper adit to the east.

The Union Mine Shaft/Adit Area also contains two additional large linear excavations. Prospect Trench 2 is located approximately 50 feet north of the shaft, and is an approximately 250 foot long, shallow, S-shaped, linear trench dug into the earth. It is consistent in shape and characteristics with the trenches in the Prospect Trenches Subsite, and is likely associated with nineteenth- or early twentieth-century exploration efforts to locate bedrock outcrops of copper sulfide ore. Open Cut 4 is located approximately 75 feet south of the shaft and consists of an approximately 120 foot long, 30 to 40 foot wide bedrock excavation. The open cut is in sulfidic schist, lenticular in plan, and plunges east at approximately 35 degrees. The hanging wall, which has partially collapsed, is supported by several wood posts. The depth of the cut is unknown as the water has risen to flood its depths. The host rock, shape, orientation, and timber support posts indicate that this cut remains from mining an isolated lens of copper ore that outcropped at the surface, similar to Open Cuts 1, 2, and 3 at the south end of the Eureka Mine.

The Union Mine Shaft/Adit Area also contains several features that appear to be associated with water collection. Basins 1, 2, 4, and 5 are clear depressions in the earth located in an arc west of the shaft. Foundation 28 is a water-filled rectangular stone well or cistern measuring 15 feet by 15 feet, with Channel 3 carrying Ephemeral Stream 7 from its northeast side and running downslope to the northeast. East of Foundation 28 is an approximately 1,000 sq ft, flat, rectangular area bounded by Berm 2 to at its east, downslope edge. This area is wet and marshy and appears to be the bottom of a reservoir that was dammed by construction of Berm 2. These features, located upslope of, or on grade with, the shaft hoist house remains, are likely associated with gathering and holding water for the steam boiler that powered the Union Mine shaft hoist, and are consistent with similar boiler water collection features found at the Elizabeth and Ely mines.

The Union Mine Adit is located approximately 250 feet northeast of the Union Mine Shaft (Figure 7-13). This adit was the main horizontal ore haulageway for the life of the Union Mine. The mouth of the adit has collapsed, leaving a shallow, watered, mud-filled trench in the earth approximately 75 feet long that extends east toward Road 2. The adit trench is approximately 6 feet deep at its west end, near where the adit mouth was located. Historically, ore containers or "skips" were raised by the cable hoist in the hoist house to an underground landing more or less level with the adit, trammed in carts by hand or mule through a transverse, horizontal crosscut that extended approximately 150 feet north from the landing. The adit then turned east 90 degrees and extended approximately 125 feet east to emerge at the adit mouth, where it was brought east to the Upper Cobbing House (Figure 7-14 for the associated underground workings).

Figure 7-12. Current photograph of Union Mine Open Cut 5, view looking northeast.

Figure 7-13. Current photograph of Union Mine Adit, view looking southwest.

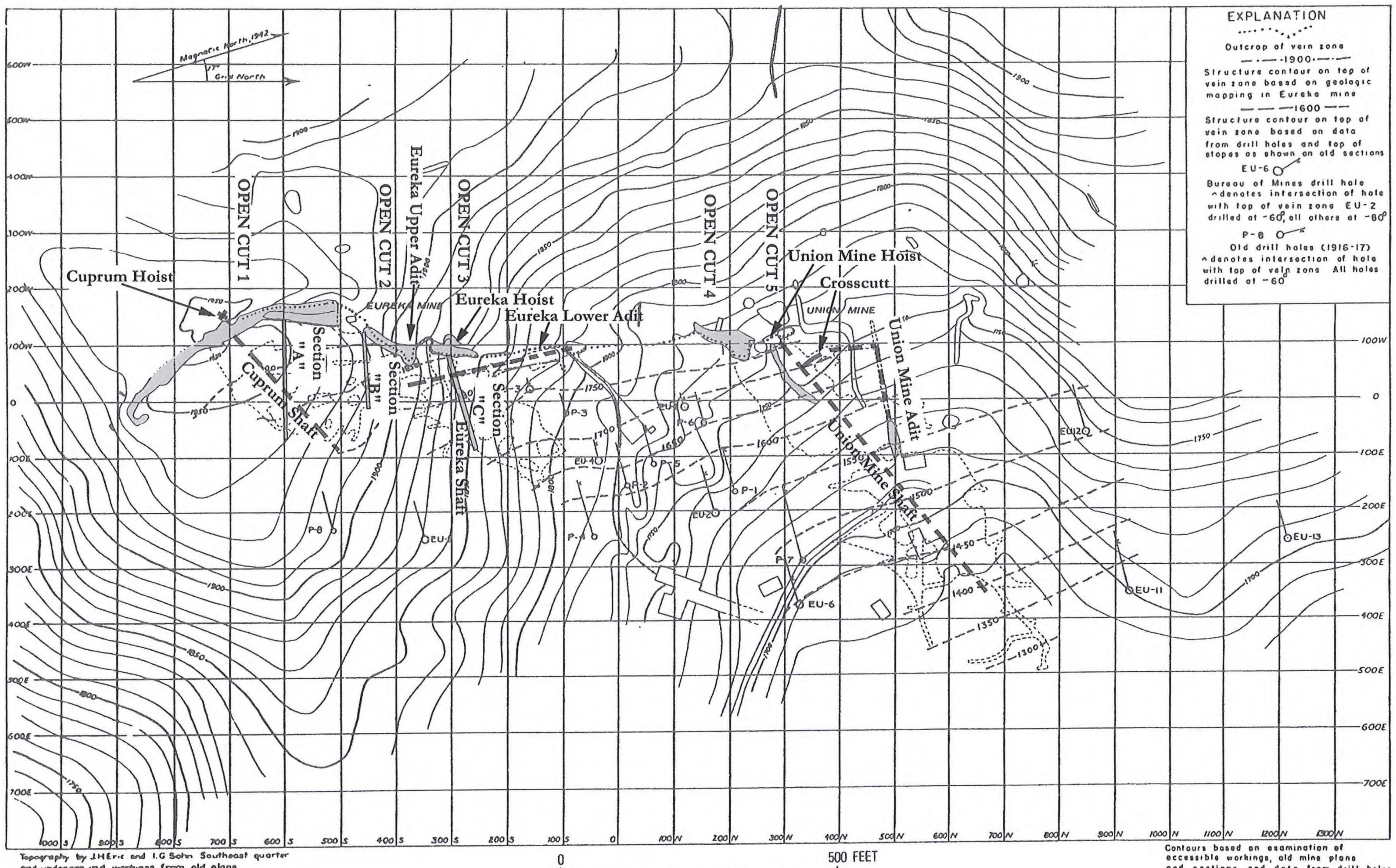

Figure 7-14. Annotated structure contour map of the ore zone of the Pike Hill Mines (source: USGS/White and Eric 1944).

Three foundations are located in a north-south line in the vicinity of the east end of the Union Adit. Foundation 27 is located approximately 100 feet north of the adit. It is a square, 15 foot by 15 foot dry-laid schist structure. This building appears to be included in one historic photograph (see Figure 7-3). The function of this building is unknown and no historic records associated with it were located during archival research. Foundation 26 is located immediately north of the east end of the Union Adit. It is a rectangular, 30 foot by 15 foot, dry-laid schist structure. This building appears to be included in several historical photographs (see Figures 7-4, 7-5, 7-6, and 7-7). The building in Figure 7-7 appears to be a side-gabled, one and one-half story, center chimney dwelling or administrative building in use during the first or second decade of the twentieth century. The building is indicated as standing in 1944 (see Figure 5-14). The function of this building is unknown and no historic records associated with it were located during archival research. Its location directly outside the adit suggests that it may originally have been a "dry house," where miners would change their clothes before and after their underground shifts. It may also have been a scale house where ore was weighed before proceeding to the Upper Cobbing Shed to the east. Foundation 25 is located approximately 30 feet south of the east end of the Union Adit, and is a 15 foot by 10 foot dry-laid schist structure. No corresponding building appears in the historical photographs. The function of this building is unknown and no historic records associated with it were located during archival research. It is possible that one of these three foundations may be for a blacksmith shop, an important component of a mine's surface plant, and one that was usually located close to the mine entrance.

Upper Cobbing House Area

Immediately east of the Union Adit, directly east of the western apex of Road 2, is the Upper Cobbing House Area, an approximately 250 foot east-west by 300 foot north-south area. This cluster of ore processing-related features includes Berm 3, Foundation 30, Foundation 31, Wall 7, Wall 9, Foundation 32, Waste Rock Pile 4, and a dam. This area technically includes Foundation 33 (Union Mine office), which is discussed in Chapter 8. Berm 3 is an oval terrace of earth approximately 100 feet long north-south by approximately 75 feet wide east-west (Figure 7-15). It appears to have been built out to the east from existing sloped topography to create a flat man-made terrace, or to have been created though excavation of the level terrace below it. Berm 3 incorporates Foundation 30 and Foundation 31 near its east lip, L-shaped Wall 7 between them, and Wall 8. Foundation 30 is located to the north and is a rectangular, 20 foot by 10 foot, dry-laid schist structure. Foundation 31 is located to the south and is a square, 18 foot by 18 foot, dry-laid schist structure.

Wall 7 is an L-shaped dry-laid schist block wall that extends east from a point between the two foundations, and turns 90 degrees to the north, forming a retaining wall at the southeast corner of Foundation 30. Wall 8 is an approximately 25 foot long schist block retaining wall located at the east foot of Berm 3, below Foundation 30. Immediately east of Berm 3 is a level, rectangular, approximately 125 foot long north-south, approximately 45 foot wide east-west platform bounded by L-shaped Wall 9 to the east and south. A secondary road leads through this area from the Road 1-Road 2 junction to the north, back to Road 2 south of Berm 3. Wall 9 is a massive retaining wall built of large schist and fieldstone blocks and boulders. The east face is approximately 8 feet high and measures approximately 125 feet long north-south. It turns 90 degrees west at its south end, and proceeds west for approximately 40 feet. Foundation 32 is located approximately 10 feet east of the north half of the longer, north-south section of Wall 9 (Figure 7-16). It is a square, approximately 70 foot by 70 foot, approximately 6 foot high raised platform with sections of schist block retaining wall, partially covered by Waste Rock Pile 4,

Figure 7-15. Current photograph of Berm 3, view looking south.

Figure 7-16. Current photograph showing Foundation 32 at left and Wall 9 at right, view looking southeast.

an approximately 80 foot diameter, conical pile of yellow, powdery ore washing fines and larger, brownish-purple pieces of oxidized pyrrhotite that spills over the north and east sides of the foundation structure. A dam is located approximately 40 feet east of Foundation 32 and consists of an approximately 40 foot long, 6 foot high wall of schist and fieldstone blocks (Figure 7-17). It holds back a small pool of water, and Ephemeral Stream 4 issues from its east (downstream) face, and flows under Waste Rock Pile 1 to the southeast to join Pike Hill Brook.

This cluster of features is associated with the Union Mine's Upper Cobbing House (see Figures 7-1 through 7-7). As shown in historical photos dating from ca. 1880, the Upper Cobbing House was a long, narrow, gable-roofed building with its long axis oriented north-south. The long east and west elevations contained numerous closely spaced rectangular windows, and the long east and west roof planes incorporated numerous dormers, indicating that there was a need for large quantities of natural light inside the building. The photographs do not include any smokestacks, suggesting that all operations inside were apparently manual at the time the picture was taken. The roof planes on the east elevation vary, with a short gable plane at the south end, a front-gable section, and a longer gable section with a deeper roof plane to the north (see Figure 7-2). Figures 7-4, 7-5, and 7-6) show a cluster of transverse-oriented, gable-roofed, attached sheds near the south end of the west elevation. These sheds appear to be located where Foundation 30 and Foundation 31 are now, opposite the south end of Wall 9. Figure 7-6 shows what appears to be an inclined track structure rising up to an elevated level of these attached sheds.

Ore from the Union Mine was trammed out the mouth of the Union Mine Adit, past the building at Foundation 26, in small rectangular ore cars riding on light, narrow-gauge rails as was almost universally the case in this kind of mining operation. The ore appears to have entered the building via an incline, a typical arrangement that allowed ore to be dumped into an elevated storage bin so it could be drawn out by gravity in batches. The ore would have then been hand cobbed with hammers on platforms inside the building. The presence of a dam and small reservoir adjacent to the building indicates that additional washing and treatment of ore fines were likely also performed in the Upper Cobbing House. The function of the flat platform formed by Foundation 32 immediately below the Upper Cobbing House is unclear, but it may have been an outdoor cobbing area or a storage platform for cobbed ore ready for shipment. Low-grade ore was discarded in two clusters of piles in the area below the Upper Cobbing House.

Historical photographs from the early-twentieth-century operations indicate that the Upper Cobbing House had been torn down by that time (see Figure 7-7). The building had been replaced with a pair of smaller, shorter, gable-roofed buildings, possibly barns, oriented at right angles to each other at the angle in the L-shaped wall. This building was indicated as standing in 1944 (see Figure 5-14). Figure 7-7 clearly shows, from right to left, the then-barren Berm 3, the flat platform where the Upper Cobbing House previously stood, the edge of Wall 9, the flat upper surface of Foundation 32, and Waste Rock Pile 5.

Waste Rock/Walls/Foundations Area

East and downslope of the Upper Cobbing House Area is the Waste Rock/Walls/Foundations Area, a complex cluster of smaller vegetated and barren waste rock piles, stone retaining walls and foundations measuring approximately 350 feet east-west by 250 feet north-south. Waste Rock Pile 5 is located approximately 50 feet east of Wall 9 (Figure 7-18). It is an approximately 75 foot diameter, conical pile of yellow, powdery ore washing fines and larger, brownish purple pieces of oxidized pyrrhotite. Waste Rock Pile 5 is visible in historical photographs from the early twentieth century (see Figure 7-7). An arc of three, smaller, oval, vegetated, conical waste rock piles ("Berm 4," "Berm 5," and "Berm 6") lies

Figure 7-17. Current photograph showing dam, view looking southwest.

Figure 7-18. Current photograph showing Waste Rock Pile 5, view looking south.

immediately to the east. Berm 6 is immediately east of Waste Rock Pile 5 and is approximately 75 feet in diameter. Berm 5 is immediately south and approximately 40 feet in diameter. Berm 4 lies to the south and is approximately 60 feet in diameter. The landscape features in this area are associated with discarding low-grade ore and ore washing fines from the Upper Cobbing Shed, which operated for the life of the Union Mine. The barren appearance of the unvegetated ore may be the result of early-twentieth-century disturbance associated with milling dump ores in the Eureka Ore Mill, and/or mid-twentieth-century disturbance associated with removal of dump ore for processing at the Elizabeth Mine. The vegetated waste rock piles ("berms") may remain undisturbed as they consist of development rock that is free of sulfide ore, or ore of such low grade that it was assayed but not disturbed for later milling campaigns.

A series of short retaining walls ranging from 40 feet to 20 feet long (Wall 1, Wall 11, and Wall 12) are located along the east flanks of these piles and consist of large blocks of ore and schist packed against the steep downslope sides of the waste rock piles to serve as retaining walls. Three shorter sections of wall (Wall 3, Wall 4, and Wall 5 are located on level ground east of Berm 6. This area includes Foundation 19, a 16 foot by 12 foot, dry-laid schist structure. Historical photographs from ca. 1880 show a long, narrow, gable-roofed building, possibly a barn, at this location, which may be associated with Foundation 19 and Wall 4 (see Figures 7-2, 7-5 and 7-6). Foundation 34 is located at the south end of this area, and is a 20 foot by 10 foot dry-laid schist structure (Figure 7-19). A building that possibly corresponds to Foundation 34 is shown in a historical photograph from ca. 1880 (see Figures 7-5 and 7-6). Wall 13 is located approximately 15 feet to the northeast and appears to be a retaining wall for Foundation 34. The function and history of the buildings associated with Foundation 19 and Foundation 34 are unknown, and no historical records associated with them were located during archival research.

The headwaters of Pike Hill Brook emerge in a steep gully immediately southeast of Foundation 34. This gully contains the remains of two trommel screens, rotating metal mesh cylinders used to separate crushed material by size (Figure 7-20). These artifacts consist of two riveted wrought sheet iron cylinders approximately 3 feet in diameter and approximately 5 feet long, with closely spaced rows of ¾ inch diameter holes in their sides. The 1906 crushing plant flow sheet for the Pike Hill Mines Co. magnetic separation operation includes a ¾ screening step, suggesting that these trommel screens date from the 1906–1907 magnetic separation campaign (see Figure 6-5).

Immediately below this cluster of vegetated waste rock piles, retaining walls, and unidentified foundations is an open, barren area containing Waste Rock Piles 1, 2, and 3, and the first visible section of Pike Hill Brook (Figure 7-21). This is the largest cluster of waste rock piles within the Union Mine Subsite. Waste Rock Pile 1 is located between Waste Rock Pile 2 to the northwest, and Waste Rock Pile 3 to the south. Waste Rock Pile 1 is an approximately 75 foot diameter conical pile of yellow, powdery fines and larger, brownish purple pieces of oxidized pyrrhotite. Waste Rock Pile 2 is a larger, oval pile, approximately 175 feet long east-west, by approximately 100 feet wide at its widest point. Waste Rock Pile 3 is similar in size to Waste Rock Pile 1. There is a flatter, open area along the south side of the piles where Pike Hill Brook descends from west to east. An abandoned modern automobile was located in this flat area at the time the survey was conducted. The landscape features in this area are associated with discarding low-grade ore and ore washing fines from the Upper Cobbing Shed, which operated for the life of the Union Mine. These waste rock piles are clearly visible in a ca. 1880 historical photo (see Figure 7-1 and 7-3). The barren appearance of these piles, and the absence of ore at the west side of the piles may be the result of early-twentieth-century disturbance associated with milling dump ores in the Eureka Ore Mill, and/or mid-twentieth-century disturbance associated with removal of dump ore for processing at the Elizabeth Mine.

Figure 7-19. Current photograph showing Foundation 34, view looking northeast.

Figure 7-20. Current photograph of one of two trommel screens, view looking northeast.

Figure 7-21. Current photograph of Waste Rock Piles 1, 2, and 3, view looking north.

Lower Cobbing House Area

The area below and east of Waste Rock Piles 1, 2, and 3 is the Lower Cobbing House Area, an approximately 400 foot east-west by approximately 150 foot north-south area that contains another cluster of features associated with ore processing. The uppermost feature is Ramp 1, an approximately 200 foot long, 15 foot wide, southwest-northeast-oriented raised inclined earth berm ore transportation ramp that begins approximately 100 feet south of Waste Rock Pile 2, 3, and 4 and extends northeast to the vicinity of Waste Rock Pile 8. It is supported in two places by Wall 15 and Wall 16, short sections of loosely laid schist and fieldstones. This ramp ends in a terraced area above Wall 14, an approximately 75 foot long wall that appears to be the rear (west) retaining wall for a long north-south-oriented ore processing building above Waste Rock Pile 6 and Waste Rock Pile 7. Wall 1 is a shorter section of retaining wall located north across Pike Hill Brook. Waste Rock Pile 6 is an approximately 50 foot diameter pile of waste ore consisting of yellow, powdery fines and larger, brownish purple pieces of oxidized pyrrhotite located immediately below and east of Wall 14. Waste Rock Pile 7 is located north of Wall 14, east of Pike Hill Brook, and is a larger, tear-drop-shaped, conical pile of similar waste ore measuring approximately 200 feet east-west by approximately 100 feet wide at its widest point (Figure 7-22). Pike Hill Brook runs along the north side of Waste Rock Pile 7. Road 11 extends east from Wall 14 and Waste Rock Pile 6, and joins Road 12, which descends east from the vicinity of Ramp 1.

The features in the Lower Cobbing House Area are likely associated with the May 1879 ore processing capacity and equipment improvements installed by the Vermont Copper Company to support mining and processing ore for smelting at the Ely Mine. At that time a “new washhouse” was built and the ore processing plant was enlarged to accommodate new jigging machines for separating fine ore and waste rock (Abbott *GMC* 1964:297–299). This building (Lower Cobbing House) and associated Waste Rock Piles 6 and 7 appear in a ca. 1880 historical photo (see Figure 7-1), and the waste rock piles and Wall 1 and Wall 14 were clearly visible in the landscape during early-twentieth-century operations (see Figure 7-3 at center). Figure 7-1 shows an elevated, gable-roofed structure above the building that is likely similar to the elevated ore tram ramp and storage bin shown in the Upper Cobbing House photographs (see Figure 7-6). Ore appears to have been trammed down Ramp 1, and cobbed, washed, and jigged in the ore washhouse building supported by Wall 14. Low-grade ore and washing fines were discarded in Waste Rock Pile 6 and Waste Rock Pile 7. The barren appearance of these piles may be the result of early twentieth-century disturbance associated with milling dump ores in the Eureka Ore Mill, and/or mid-twentieth-century disturbance associated with removal of dump ore for processing at the Elizabeth Mine. Road 11, and Road 12 visible in Figures 5-1 and 5-3, may be abandoned remnants of the ore haulage road built to haul processed ore from Pike Hill to the Ely Mine smelter, and contain numerous lumps of oxidized pyrrhotite-chalcopyrite ore in their roadbeds.

The easternmost cluster of features in the Union Mine Subsite are located approximately 100 feet east of Waste Rock Pile 7. The central feature in this area is Concrete Pier 1, a low, small, deteriorated concrete pier with two short vertical iron pins in its flat upper surface. The pier lies at the foot of what appears to be a man-made trench that extends several dozen feet to the southwest. Basin 3, a shallow circular depression, and Berm 8, a flat, rectangular area, are located immediately west of the pier. The function or purpose of these features is unknown. The pier may possibly be a support associated with the electrical power transmission line installed for World War I operations. No historical records associated with these features were located during archival research.

Figure 7-22. Current photograph of Waste Rock Pile 7, view looking west.

Eureka Mine Subsite

The Eureka Mine Subsite is located near the center of the Pike Hill Mines Site, just north of the summit of Pike Hill, south of the Union Mine Subsite, and north of the Prospect Trenches Subsite. The Eureka Mine Subsite is a 14.9 acre, approximately 1,400 ft northeast-southwest, approximately 500 foot wide, crescent-shaped area, containing mine openings, machinery remains and bases, waste piles, foundations, roads, and materials handling and water collection features associated with underground mining, ore handling and processing, and associated support functions. Like the Union Mine Subsite, the features are arranged downslope, in this case from southwest to northeast, following the logical sequence of mining, processing, waste disposal, and transportation as aided by gravity. The Eureka Mine Subsite can be divided into four discrete geographic areas that correspond chronologically to the extraction of ore from separate aboveground and/or underground workings and the associated processing and waste disposal: the Cuprum Cut/Shaft Area, the Eureka Upper Adit/Shaft Area, the Eureka Lower Adit/Blacksmith Shop Area, and the Eureka Ore Mill Area. The following descriptions and interpretations follow the landscape and mining features from the southwest to the northeast.

Cuprum Cut/Shaft Area

The Cuprum Cut/Shaft Area is located at the south end of the Eureka Mine Subsite. It is an approximately 500 foot long north-south by approximately 300 foot wide, oval area that extends from the Prospect Trenches Subsite on its south side to Open Cut 2 to the north.

The most prominent and dramatic landscape feature of the Cuprum Cut/Shaft Area is Open Cut 1, an approximately 400 foot long linear bedrock trench measuring approximately 20 feet wide at its south end and approximately 60 feet wide at its north end (Figure 7-23). The long axis of the cut is oriented north-south, and it hooks around to the east and north at its south end, following the folding of the orebody within its enclosing schist walls. This excavation was made on the exposed, sheet-like orebody, and followed it underground, leaving an approximately 10 foot high open cut that plunges down to the east at approximately 35 degrees. The foot wall and hanging wall are schist, and large sections of incompetent hanging wall have fallen in places, partially or completely blocking the open cut. Features associated with mining activity are visible and include drill steel holes (Figure 7-24), and hanging wall props consisting of timbers and schist block packwalls.

This open cut was the site of the first major surface mining efforts in 1854 under the Corinth Copper Company, which dug ore by hand during the part of the year when the ground was not frozen. In 1856 the company ceased surface mining activity (Abbott *GMC* 1964:290; Jacobs 1944:11–12). Mining activity resumed in August 1863 when the company sunk an inclined shaft at the site of the “Cuprum” mine open cut, and opened up the orebody in underground drifts to the north and south (see Figure 7-14). By 1864 the shaft had been sunk 80 ft, and an adit (Upper Adit) driven about 112 ft. By 1868, when the mine closed, it was said to be more than 400 feet deep (Farnham 1872:624–625). In 1907, after the Pike Hill Mines Company reopened the mine, the company “stoped” (mined upward) from the top of the lower Eureka ore lens into the bottom of the higher Cuprum lens above, connecting the two overlapping orebodies. The company then installed a small gasoline-powered surface hoist at the old Cuprum Shaft to aid efforts to clean out pockets of unmined ore in the Cuprum Mine orebody. This hoist augmented a second gasoline hoist installed at the Eureka Shaft lower down the hill to work the deeper lenses within the mine (Pike Hill Mines Co. 1906–1907 Harry Hunter Letterbooks).

Figure 7-23. Current photograph of Cuprum Open Cut 1, view looking northwest.

Figure 7-24. Current photograph of drill steel holes, Cuprum Open Cut 1, view looking northeast.

At the approximate midpoint of Open Cut 1 is the Cuprum Hoist House area, a cluster of features located on the west side of the cut that are associated with underground mining hoisting operations via the Cuprum Shaft. The site of the hoist house is a flat area approximately 30 feet long east-west by approximately 20 feet wide, located approximately 30 feet west of the west edge of the open cut (Figure 7-25). This area is bounded to the south by a rock ledge that appears to have been altered to form part of the flat platform. The primary feature is a machinery base measuring approximately 8 feet long by approximately 3 feet wide (Figure 7-26). This base consists of a grid of three parallel longitudinal, east-west-oriented, rotting wood timbers, with evidence of four transverse timbers, all at ground surface level. The timbers incorporate nine, vertical, 2-inch outside-diameter threaded steel pipes. Each pipe in turn surrounds a ½-inch diameter steel pin extending 9 inches above the ends of the pipes, with threads on the upper 1-1/8th inch of each pin (Figure 7-27). There are two masonry features immediately adjacent to the hoist base. Approximately 4 feet west of the base is a 4 foot long east-west by 3 foot wide, low, rectangular, mortared brick and fieldstone base or foundation. Approximately 3 feet south of, and parallel to, the machinery base, is a 20 foot long east-west, 4 foot wide mortared stone and brick base or foundation. The function of these two bases is unknown. Approximately 30 feet east of the machinery base, the west edge of Open Cut 1 curves out to form a trench that slopes down into the cut. The trench leads down toward a pair of parallel, approximately 5 foot thick, schist block packwalls located 8 feet apart that support the hanging wall of the open cut (Figure 7-28).

Pike Hill Mine Company records for 1906 indicate that an 8 hp Fairbanks Morse gasoline hoisting engine was in use at the top of the Cuprum Shaft (Pike Hill Mines Co, Harry Hunter letterbooks 1906–1907). The pattern of the nine mounting pins at the Cuprum Shaft (see Figure 7-26) closely resembles an illustration of a Fairbanks-Morse petroleum hoist base (see Figure 6-10) (Twitty 2002:177). The gasoline-powered hoist would have required a fuel tank, which may have been supported by one of the masonry bases. The hoist equipment would have been sheltered by a small building, however, the topography is indistinct and there is no evidence of a foundation, indicating that the building may have been of temporary construction, possibly with wood sills. The cables for inclined shaft hoist drums typically rode on rollers mounted to the ground, as seen at the Ely Mine. The rollers at the Cuprum Shaft presumably extended east, down the sloping trench, and between the packwalls into the mine. There is lack of visible firebrick, coal, cinders, etc. on the surface in this area, which would be diagnostic for a steam-powered hoist. That material would also be diagnostic for a blacksmith shop; most mines had one near the entrance for sharpening and tempering drills, and for maintenance and repairs. No evidence of a blacksmith shop was found in this area during the survey.

Pike Hill Mines Company records also refer to the Cuprum Shaft as the “horse whim shaft.” The original 1863–1868 hoist was apparently a “horse whim,” a crude, but functional apparatus developed by Cornish miners in the seventeenth or eighteenth century. The horse whim consisted of a small barn sheltering one or two horses attached to a harness beam, which walked in a circle, turning a wood drum or reel with a rope attached to it that raised or lowered the ore bucket in the mine shaft. This was a significant improvement of hand windlasses, and provided greater production in deeper shafts (Figure 7-29). This was considered the state-of-the art hoisting system in the 1860s, but was outstripped by steam hoists by the 1880s. Horse whims could only lift about 800 lbs about 300 feet, and only at 50 to 80 feet a minute, but were ideally suited for smaller, remote mines. Horse whims remained in use until 1910 at some small mines (Twitty 2002:19; 158–163). Figure 7-30 illustrates the archaeological remains of a horse whim. The longer, narrower masonry feature at the Cuprum Hoist House, south of the gasoline hoist base, resembles the horse whim cable hoist trench in Figure 7-30, and is also in the same alignment in relation to the shaft.

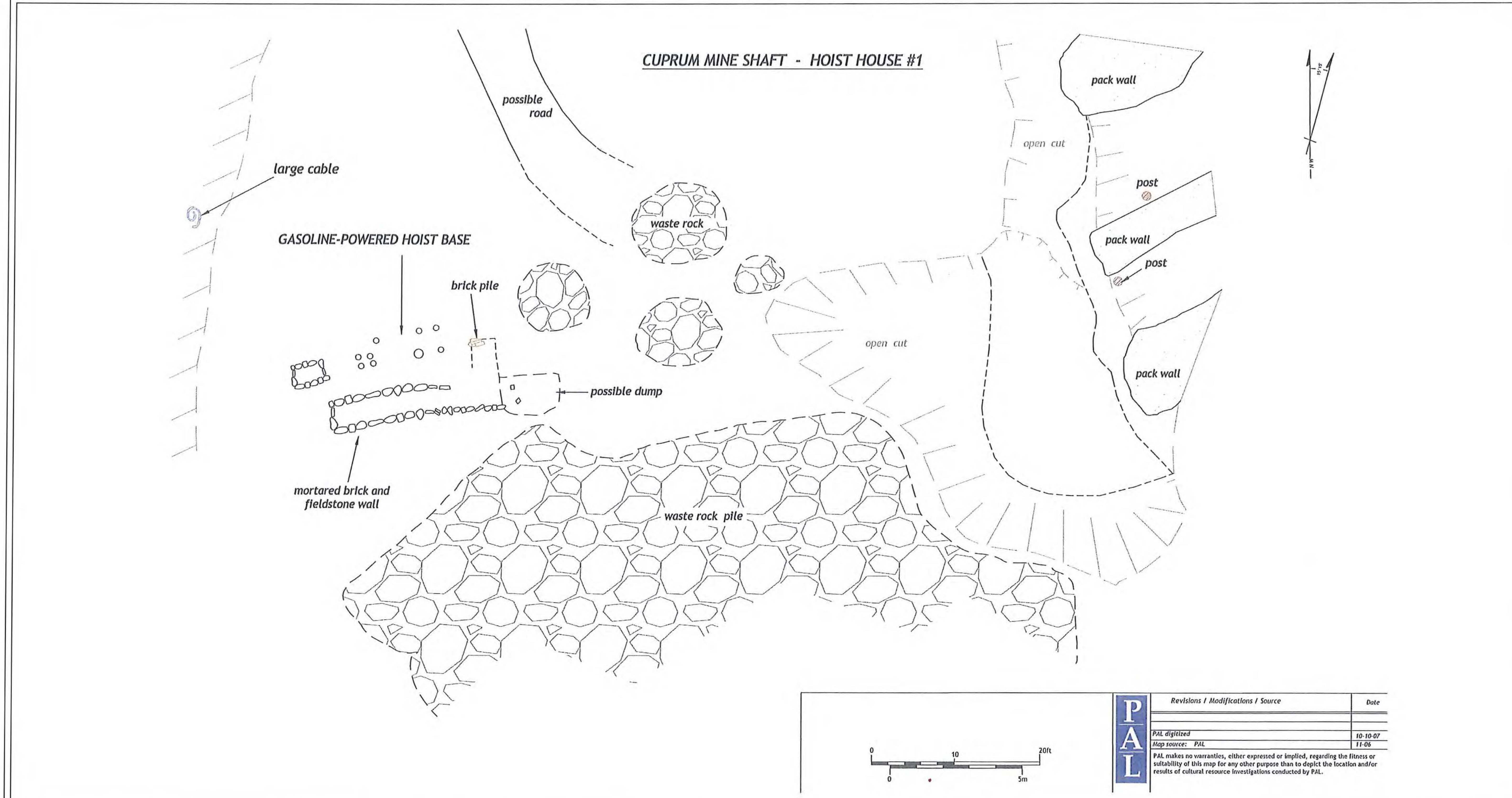

Figure 7-25. Detail plan of Cuprum Mine hoist house area

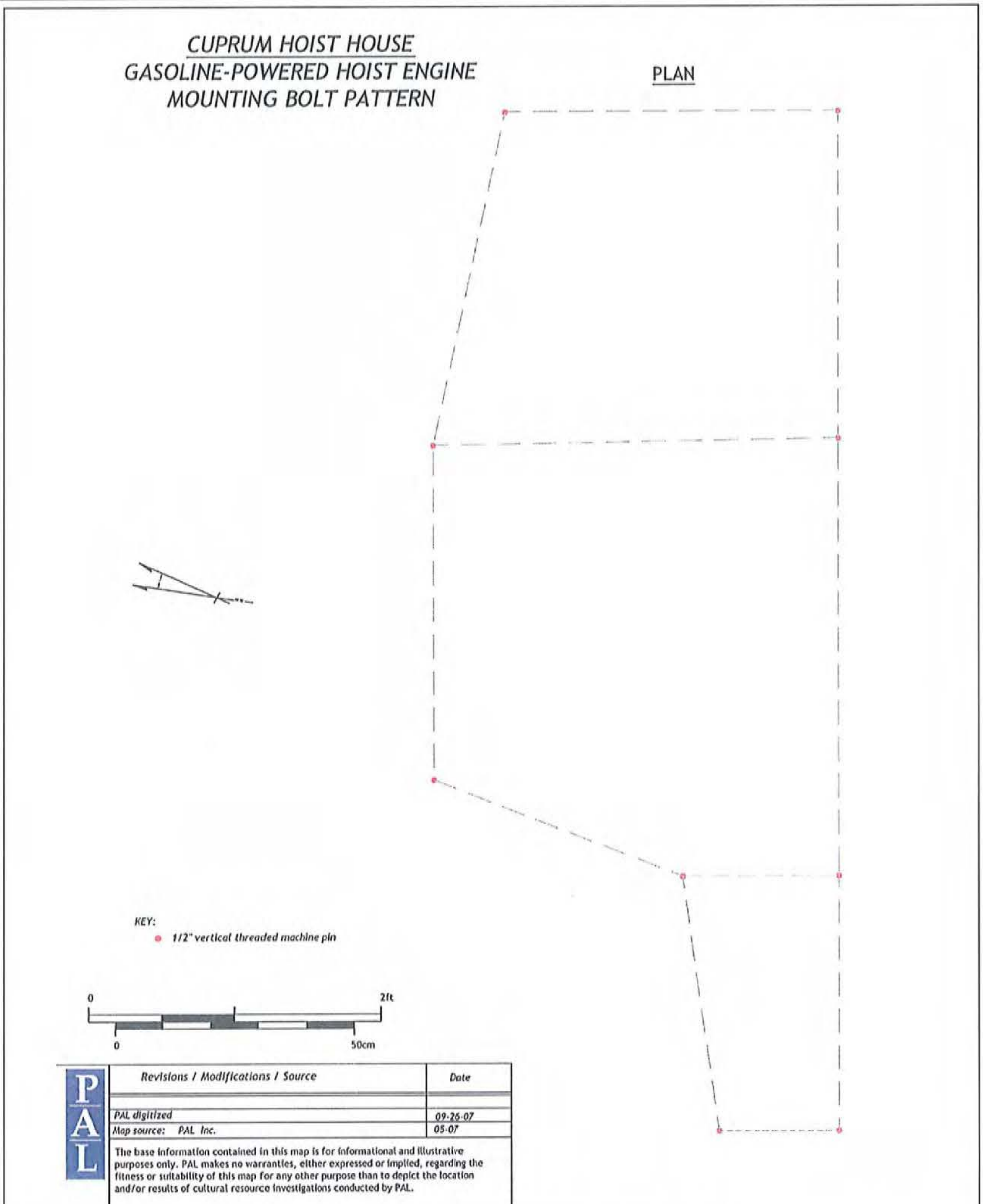

Figure 7-26. Detail plan of Cuprum Mine petroleum hoist mounting pin pattern.

Figure 7-27. Current photograph of Cuprum Mine hoist house petroleum hoist mounting pin, view looking west.

Figure 7-28. Current photograph of Cuprum Shaft packwalls and timber mine props, view looking southeast.

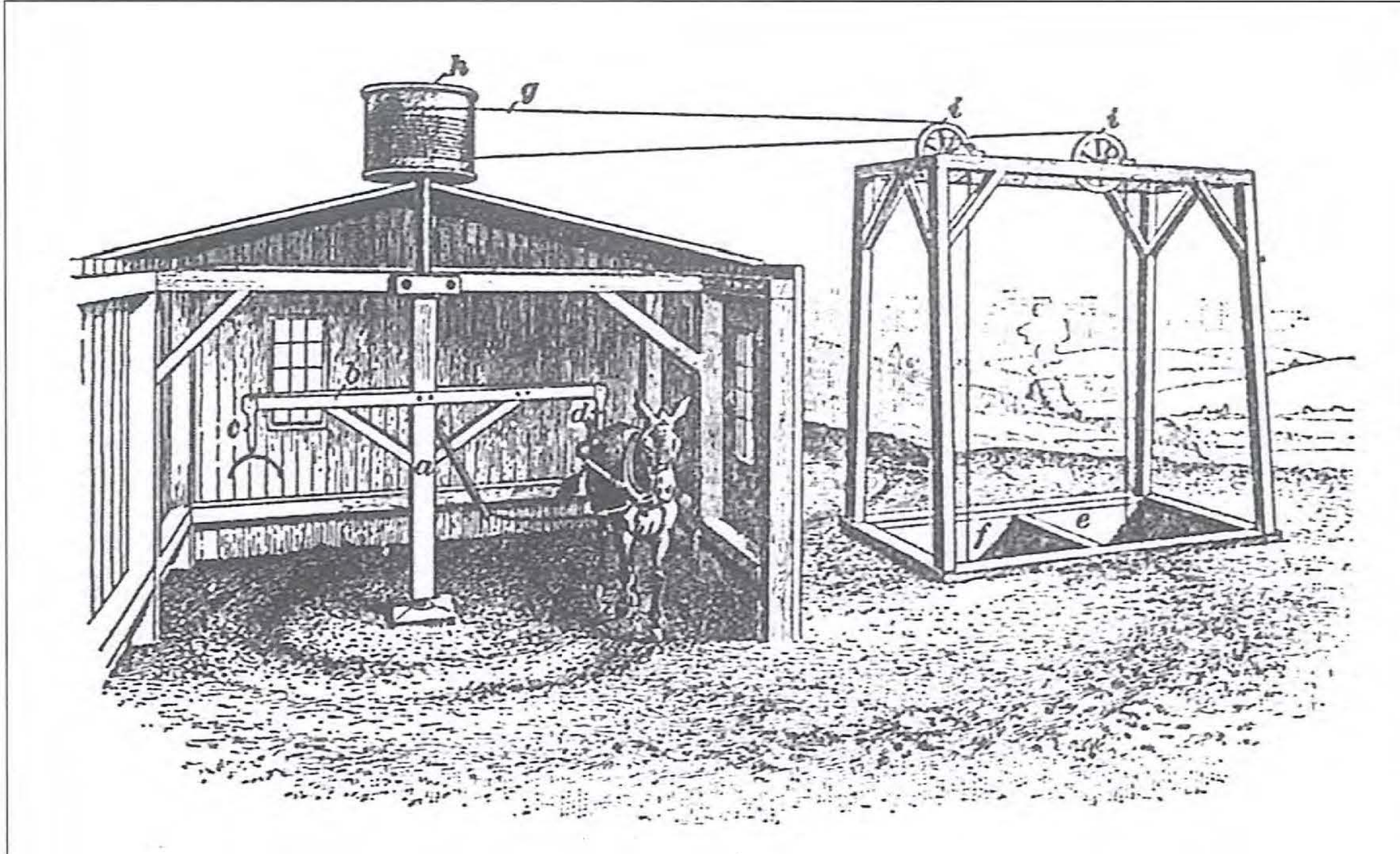

Figure 7-29. Illustration of typical horse whim (source: Twitty 2002:19).

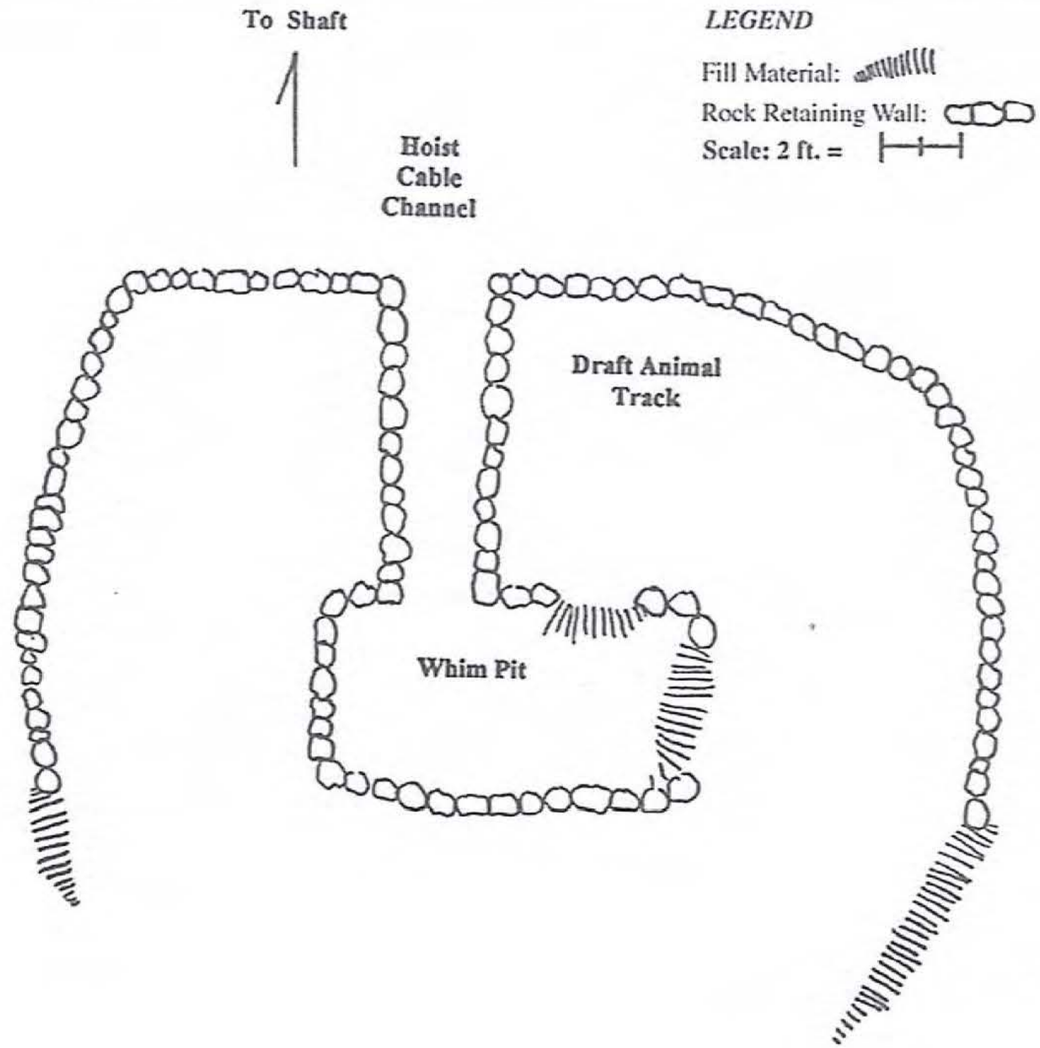

Figure 7-30. Archaeological site plan of Colorado horse whim site (source: Twitty 2002:160).

Road 5 begins at the middle of the west side of Open Cut 1, in the vicinity of the Cuprum Hoist House features, and extends in an arc northwest, north, and northeast into the adjacent Eureka Shaft/Upper Adit Area. North of Waste Rock Pile 33, Road 5 does not appear to be the remains of an actual road, as it traverses some extremely rough dump pile terrain. Vehicular access to the Cuprum Shaft area appears to have been via Road 4, which begins at the north end of Waste Rock Pile 33, and continues northwest and north to meet Road 2.

Approximately 75 feet northwest of the Cuprum Hoist House feature, immediately east of Road 5, is an approximately 50 foot long, approximately 15 foot wide, level fieldstone platform, with its long axis oriented northwest-southeast (Figure 7-31). This may have been a foundation for a blacksmith shop or building of unknown function, or it may have been an ore cobbing platform. No historical records associated with this feature were located during archival research.

Road 5 passes through a complex of 10 conical waste rock piles consisting of yellow, powdery fines and larger, brownish purple pieces of oxidized pyrrhotite. Waste Rock Piles 32, 33, and 41 are located west of the junction of Road 4 and Road 5. Waste Rock Piles 29, 30, and 31, are located east of the junction, between Road 4 and Road 5. Waste Rock Piles 34 and 28 are located north of the stone platform, west of Open Cut 1, and east of Road 5. Waste Rock Piles 27 and 40 lie to the north, and are bisected by Road 5. The piles range in size from Piles 29 and 34, which are approximately 110 feet long by 60 feet wide, down to Piles 35 and 41, which are approximately 30 feet long and 15 feet wide. These piles are low-grade ore discarded from cobbing operations associated with ore removed from Open Cut 1 and the Cuprum Shaft. The barren appearance of these piles may be the result of early-twentieth-century disturbance associated with milling dump ores in the Eureka Ore Mill, and/or mid-twentieth-century disturbance associated with removal of dump ore for processing at the Elizabeth Mine.

Eureka Shaft/Upper Adit Area

The Eureka Shaft/Upper Adit Area is located between the Cuprum Cut/Shaft Area and the Eureka Lower Adit/Blacksmith Shop Area, north of Open Cut 4 and south of the Eureka Lower Adit. It is a steeply sloped, approximately 450 foot long north-south, approximately 200 foot wide area bisected by Road 5, which is a steep, winding footpath for most of its length within the subsite.

The southernmost feature is Open Cut 2, located approximately 20 feet north of Open Cut 1, east of Road 5. It is an approximately 100 foot long linear bedrock trench measuring approximately 20 feet wide at its south end with an approximately 40 foot wide pit at its north end. The long axis of the cut is oriented north-south. The cut is less distinct than Open Cut 1, with more collapsed hanging wall and soil, and little visible bedrock. Approximately 30 feet north of Open Cut 2 is Open Cut 3, an approximately 75 foot long linear bedrock trench measuring approximately 20 feet wide. The long axis of the cut is oriented north-south. This excavation was made on the exposed orebody, and followed it underground, leaving an open cut that plunges down to the east at approximately 35 degrees. The foot wall and hanging wall are schist, and sections of incompetent hanging wall have fallen in places. There are several visible drill steel holes. At the approximate center of the cut is a large hole following the eastward plunge of the orebody, opposite a steep gully or ramp cut into the west side of the footwall of the cut (Figure 7-32).

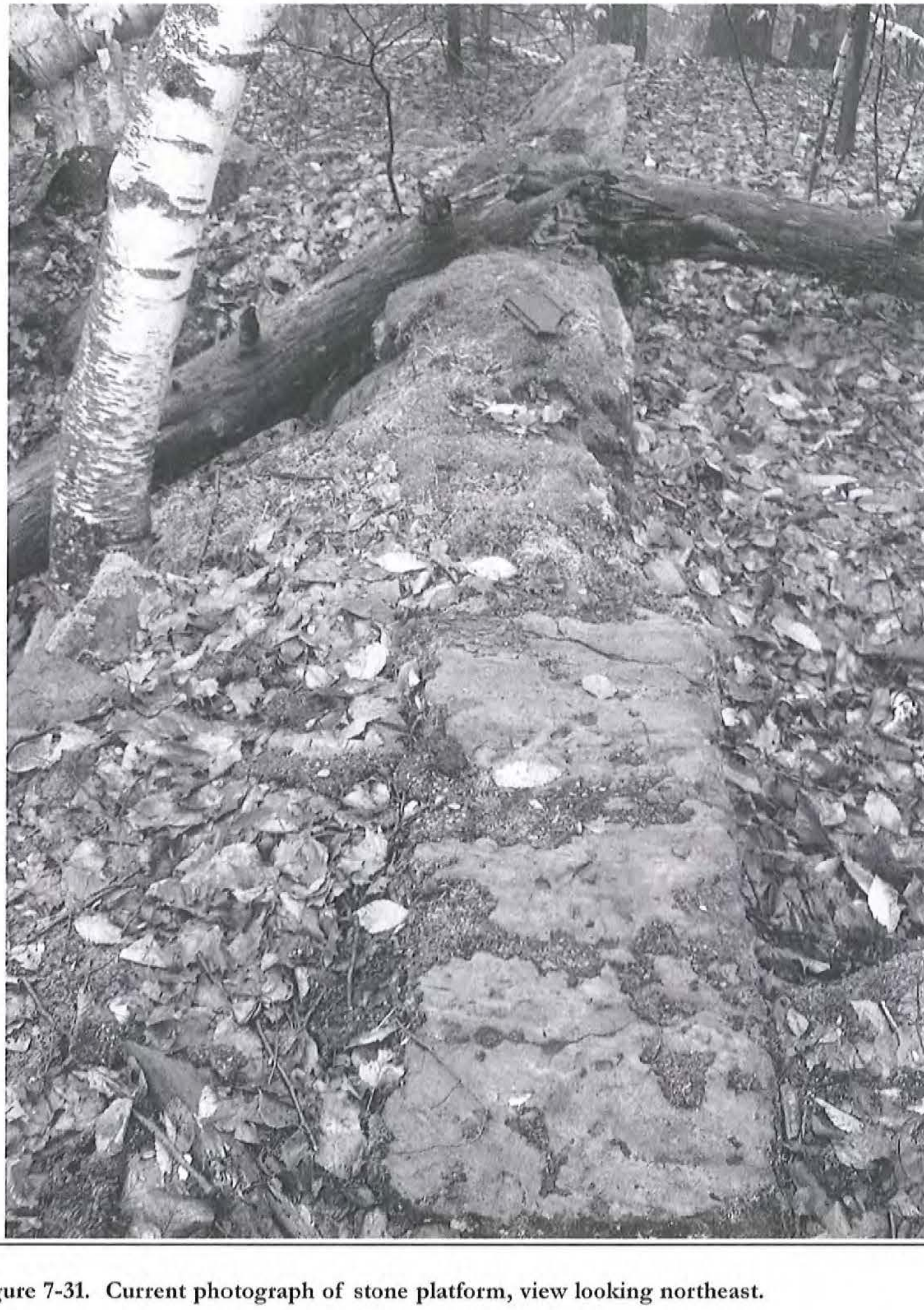

Figure 7-31. Current photograph of stone platform, view looking northeast.

Figure 7-32. Current photograph of Eureka Mine Shaft, view looking east.

Approximately 20 feet west of the edge of the gully is Foundation 36, a rectangular, 45 foot long east-west by 35 foot wide, level area. This platform was cut into the rock ledge on its east and south sides, and has a slightly raised lip on its east and north sides, suggesting a buried masonry foundation. No surface evidence of machinery bases or internal walls or features was observed. A single wrought-iron pin was found in the bedrock ledge on the south side of the foundation. Foundation 36 is bounded on its north side by Wall 23, an approximately 10 foot high, deteriorated schist and fieldstone block wall. Wall 23 forms the south side of Foundation 12, an approximately 45 foot long east-west, approximately 25 foot wide level platform. Beginning at the west side of Foundation 12 and extending northeast for approximately 225 feet is Ramp 2, an approximately 10 foot wide earth and rock embankment incline with a smooth top surface that slopes down to the northeast, passing along the east side of the Eureka Lower Adit and into the Eureka Lower Adit/Blacksmith Shop Area (Figure 7-33). The west side of the ramp is supported by two surviving sections of schist block retaining walls, one west of and immediately north of Foundation 12, and another due south of the south end of the Eureka Adit trench, north of Waste Rock Pile 21.

Northeast of and below Foundation 36 and Foundation 12, Ramp 2 and Road 5 pass through a complex of six conical waste rock piles consisting of yellow, powdery fines and larger, brownish purple pieces of oxidized pyrrhotite. The largest of these, Waste Rock Pile 21, is located west of Ramp 2. It is an oval pile measuring approximately 110 feet long north-south by approximately 60 feet wide. The rest of the waste rock piles are smaller, measuring approximately 75 to 50 feet in diameter. Waste Rock Pile 23 is located south of Waste Rock Pile 21. Waste Rock Piles 22 and 24 are located between Ramp 2 and Road 5, and Waste Rock Piles 25 and 26 are located to the east and are bisected by Road 5.

Open Cut 2 appears to be the location of the Upper Adit. According to one historical account, in 1864, the year after underground mining commenced, an adit was driven on the orebody about 112 ft (Farnham 1872:624–625). Correlation of Open Cut 2 to the 1944 USGS Map (see Figure 7-14) and geologic cross sections diagrams (Figure 7-34) indicates that the roof of an “upper adit” was located at the 1,900 foot level in the mine only 50 feet south of Open Cut 2, and that a horizontal underground tunnel extended north to the surface, about where the north end of Open Cut 2 is located. This correlation confirms the historical accounts that indicated there were two adits at the Eureka Mine. Adits are usually driven to the lower reaches of underground mines to facilitate horizontal haulage of ore from the mine, and/or for drainage. According to one account, when the mine closed in 1868, one of the adits caved in, and the mine quickly flooded (Abbott *GMC* 1964:293–294). The collapsed condition of Open Cut 2 today suggests that this is indeed the collapsed Upper Adit. The Upper Adit may have also been used for ore haulage until it collapsed. Ore could have been trammed out the adit, across the relatively level ground following Road 5 to the northwest, and dumped off Wall 23 into Foundation 12, which could have been a cobbing shed, which would explain the ring of six large waste rock piles immediately adjacent and downslope to it. Ramp 2, which begins at the west side of Foundation 12, would have served as the inclined plane for lowering the cobbed ore to the mine road network below for shipment offsite.

Open Cut 3 appears to be the location of the Eureka Shaft. According to historical sources, when the mine reached 400 feet in depth during the Corinth Copper Company’s 1863–1868 campaign, the Lower Adit was driven to intersect the Cuprum Shaft and lower levels of ore. The adit, described variously as 500 to 1,000 feet in length, missed the shaft, but did intercept a new orebody that was called “Eureka.” This adit also allegedly met the Cuprum workings near their lower end, where the lens was pinching out. This part of the orebody proved discouraging, and mining efforts were concentrated on “thicker sections,”

Figure 7-33. Current photograph of ramp 2, view looking southeast.

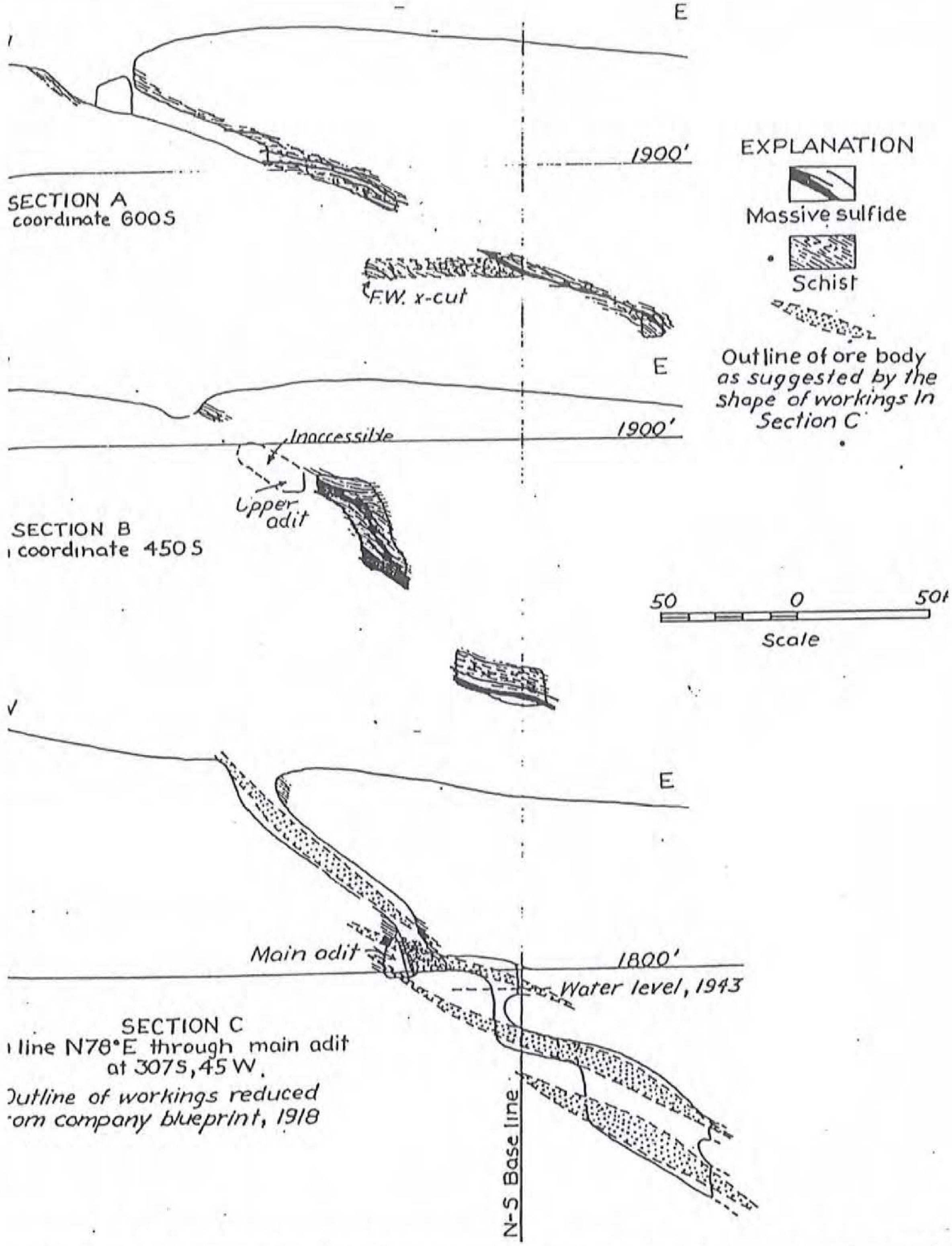

Figure 7-34. Geologic cross sections of Eureka Mine, Corinth, VT (source: USGS/White and Eric 1944:26a).

possibly meaning the lower lenses of ore (Abbott *GMC* 1964:293–294; Jacobs 1944:11–12; Perkins 1916:198). Clearly, as new ore was discovered 300 feet east of the original Cuprum Shaft, at depths increasingly lower than the Cuprum workings and below the Lower Adit level, new, deeper hoisting capability was needed north and lower down the hill from the Cuprum Shaft.

According to the 1944 USGS Map (see Figure 7-14) and accompanying Geologic Cross Section “C” (see Figure 7-34), the Lower Adit extends approximately 200 feet south into the underground workings before encountering a landing where Cross Section “C” is drawn. At this point an eastward crosscut in the second ore lens leads to a short winze that descends to the third ore lens. On the axis of Section C, the third lens, its footwall rock, and the fourth lens below were mined out in a large stope. Immediately west of the landing at the end of the Lower Adit on Section C, on the surface, is the gully in the west side of Open Cut 3, opposite foundation 36. All of these underground workings and aboveground features are on roughly the same axis, which appears to be the vertical haulage axis for the Eureka Shaft.

Under this scenario, Foundation 36 appears to have been the Eureka Hoist House, its location dictated by the surface intersection of the haulage axis. Like the Union Hoist House and Cuprum Hoist House, it had to be located in a specific place, requiring excavation of rock ledge. During the 1860s campaign, the Eureka Shaft may have been used to haul ore to the surface over a short headframe, from which it could have been dumped off Wall 23 into Foundation 12, which could have been a cobbing shed. This would explain the ring of six large waste rock piles immediately adjacent and downslope to it. Ramp 2, which begins at the west side of Foundation 12, would have served as the inclined plane for lowering the cobbed ore to the mine road network below for shipment offsite. There is no documentary or physical evidence that the hoist was steam-powered, and it was very likely a horse whim similar to the one at the Cuprum Shaft. In the early twentieth century, the Pike Hill Mines Company used the Eureka Shaft as the primary deep hoisting shaft, raising ore to the landing at the Lower Adit and tramming it out that adit for cobbing and milling. Pike Hill Mines Company records include an account of parts from the Fairbanks Morse 8 hp gasoline hoisting engine at the top of the Cuprum Shaft being removed to repair the Eureka Shaft hoist engine (Pike Hill Mines Co. 1906–1907 Harry Hunter Letter Books).

Waste Rock Piles 21, 22, 23, 24, 25, and 26 are discarded low-grade ore from cobbing operations, apparently performed within Foundation 12. As discussed above, the ore was either taken from the Upper Adit located in Open Cut 2, and/or raised from the Eureka Shaft during 1863–1868 operations. The barren appearance of these piles may be the result of early-twentieth-century disturbance associated with milling dump ores in the Eureka Ore Mill, and/or mid-twentieth-century disturbance associated with removal of dump ore for processing at the Elizabeth Mine.

Eureka Lower Adit/Blacksmith Shop Area

The Eureka Lower Adit/Blacksmith Shop Area is located between the Eureka Shaft/Adit Area and the Eureka Mine Ore Mill Area, north of Ramp 2. It is a moderately sloped, approximately 450 foot long north-south, approximately 250 foot wide area centered on the junction of Roads 5, 15, and 16.

The southernmost feature is the Eureka Adit, located just west of and parallel to Ramp 2. At the surface, this feature consists of an approximately 140 foot long, northeast-southwest-oriented, approximately 15 foot wide, linear vertical open cut in the bedrock (Figure 7-35). At the north end is a partially collapsed reinforced concrete adit portal wall dating from the early-twentieth-century operations. Wall 22, located on the northwest inner face of the trench, just southwest of the portal wall, is a short section of fieldstone retaining wall. The floor of the cut is watered, and shows signs of recent excavations to improve drainage

Figure 7-35. Current photograph of the Eureka Mine Lower Adit trench and portal wall, view looking southwest.

from the flooded underground workings. The entrance to the underground workings is located on the east side of the south end of the cut, where a tunnel extends underground on the strike of the orebody (Figure 7-36). The eastward dip of the enclosing rock strata is clearly visible in the sloping hanging wall on the left side of the adit. The floor is watered, and several round wood timber mine props remain in place, supporting the hanging wall.

According to the 1944 USGS Structure Contour Map (see Figure 5-14) and accompanying Geologic Cross Section "C," (see Figure 7-34), the adit extends approximately 200 feet south into the underground workings before encountering a landing where the vertical haulage axis for the Eureka Shaft is located.

The Eureka Lower Adit is the later, lower, and longer of the two Eureka Mine adits. Variously described in historical references as being between 500 and 1,000 feet long, it was begun toward the middle of the Corinth Copper Company's 1863-1868 campaign. According to one source, when the mine reached 400 feet in depth, a new 500 ft long adit was driven, but missed the shaft by 75 feet (Abbott *GMC* 1964:293–294). The shaft in question appears to have been the Cuprum Shaft. According to other sources, a 1,000 ft long adit was driven at a "lower level" to intercept the "lode," which was then called "Eureka." This adit also allegedly met the Cuprum workings near their lower end, where the lens was pinching out. This part of the orebody proved discouraging, and very little work was done on it in favor of "thicker sections," likely meaning the lower lenses of ore (Jacobs 1944:11–12; Perkins 1916:198). This adit was the primary horizontal haulageway for the latter part of the Corinth Copper Company's 1863–1868 campaign, and the Pike Hill Mines Company's two early-twentieth-century campaigns. Vertical hoisting in the twentieth century was accomplished by the two surface-mounted gasoline-powered Fairbanks Morse hoists. One of these was located at the Cuprum Shaft, and the other at the Eureka Shaft. Both of the gasoline hoists raised ore to landings in the mine, from which it was trammed horizontally to and through the Lower Adit.

Foundation 43 is located approximately 50 feet east of the northeast end of the Lower Adit. It is a rectangular, 75 foot long east-west by 30 foot wide dry-laid schist block structure. The function of this building is unknown and no historical records associated with it were located during archival research. Its size and location directly outside the adit suggests that it may originally have been a "dry house," where miners would change their clothes before and after their underground shifts.

Immediately north of the Lower Adit is the junction of several historical mine roads. Road 5 forks to the northwest to join Road 4 east of Open Cut 4. Road 15 proceeds northeast into the Eureka Ore Mill Subsite, passing south and east of the mill to join Road 2. Road 16 extends east, then northeast to join Road 2 at a point farther east.

The area north of the Lower Adit and Foundation 43 is occupied by an approximately 300 foot diameter cluster of large conical waste rock piles bounded by three historic roadways. East of the Lower Adit is Waste Rock Pile 19. Bounded by Road 15 on its north side and Road 16 on its south side, it is an approximately 150 foot long east-west, approximately 50 foot wide oval pile of vegetated, segregated development rock, relatively free of sulfide mineralization. North of this, north of Road 15 and east of Road 5, is a cluster of eight conical piles of yellow, powdery fines and larger, brownish purple pieces of oxidized pyrrhotite. The largest of these piles are Waste Rock Pile 18, immediately north of the Road 5-Road 15 fork, which measures approximately 100 feet by 75 feet; and Waste Rock Pile 15, and irregularly shaped pile measuring approximately 110 feet in diameter. These two waste rock piles are visible in Figure 7-7. Smaller Waste Rock Piles 16 and 17 are located northeast of Waste Rock Pile 18, and smaller Waste Rock Piles 11, 12, 13, and 14 are located northeast of Waste Rock Pile 15. These waste rock piles

Figure 7-36. Current photograph of the Eureka Mine Lower Adit mouth, looking southeast.

appear to be associated with early-twentieth-century hand cobbing operations for collecting high-grade ore for direct shipping. Figure 7-7 shows, near the right hand side, an elevated tramway ending at a small cobbing shed atop Waste Rock piles 10–15. The barren appearance of these piles may be the result of early-twentieth-century disturbance associated with milling dump ores in the Eureka Ore Mill, and/or mid-twentieth-century disturbance associated with removal of dump ore for processing at the Elizabeth Mine. Comparison between the neat, consolidated appearance of these waste rock piles as shown in Figure 7-7 and the more numerous, scattered, segregated piles present today supports later disturbance.

Foundation 21, the Eureka Mine blacksmith shop, is located approximately 50 feet northeast of the east end of the Lower Adit, within the south end of Waste Rock Pile 18, north of the junction of Roads 4 and 15 (Figure 7-37). Foundation 22 is a square, 30 foot by 30 foot feature with a square, 15 foot by 15 foot annex attached to the north corner. The foundations consist of low, linear berms of earth with minor exposure of stone blocks and concrete. The southwest side of the foundation is open. The southeast and northeast sides are indicated by linear mounds of earth approximately 30 inches wide. An 8 foot long section of stone retaining wall is located on the outside of the west end of the southeast side, and 6 foot long section of broken wood plank is located on the inside edge of the same side, near the east end. The northwest side is indicated by a linear mound approximately 4 feet wide. An 8 foot long section of light gauge, wrought-iron mine car rail protrudes from the concrete at the west end of this wall, and appears to have been incorporated as a crude reinforcing bar. The north annex walls are indicated by linear features approximately 2 feet wide, and there is a 3 foot wide gap, possibly for a doorway, at the east end of the southeast side.

The larger, 30 foot square interior area contains a prominent feature associated with blacksmithing operations, a forge (Figure 7-38). The forge is located 4 feet southwest of the northeast wall, and is approximately centered between the northwest and southeast walls. It consists of a 48 inch diameter riveted sheet iron cylinder, which appears to be a former steam boiler shell (Figures 7-39, 7-40). The cylinder rises 42 inches from the floor. There is a 32 inch high, 12 inch wide, forge draft opening in the front (southwest) side of the forge, 8 inches below the upper lip. The interior is lined with brick, which has fallen out forming a small fan in front of the opening. This opening appears to be where the blast pipe from the bellows or blower led to the tuyere (nozzle) at the base of the forge, as there are no other penetrations in the outer shell. The interior of the shell is filled with mortared brick to form a rectangular, 38 inch long, 14 inch wide, heating pit. The pit incorporates a steel plate near the front edge, and two parallel sections of light-gauge, wrought-iron, mine car rail set into the mortared brick, transverse to the long axis of the pit. The collapsed remains of a working platform are located at the front of the forge and consist of a 47 inch long, 29 inch wide, riveted angle iron frame connected to the forge shell by wrought-iron straps. A fragment of sheet iron working surface remains riveted to the south corner of the frame. The use of a recycled steam boiler for the forge indicates adaptive reuse of scrap metal items to fabricate a forge rather than purchasing a purpose-built unit and having it shipped to Pike Hill.

Figure 7-7 shows the blacksmith shop at the extreme right edge, on top of Waste Rock Pile 18. In the photograph, a tall, narrow smokestack, likely the forge stack, protrudes from the roof, and a series of sheds of unknown function extend to the northeast. A well-equipped blacksmith shop was one of the most important elements of a mine's physical plant. In addition to general metalworking and light welding and forging for maintenance and repairs, the blacksmith shop's primary function was sharpening and re-hardening the long drill bits, or "steels" used to drill holes in the rock in the mine for explosive charges. The dull bits on the working ends of the drill steels had to be sharpened, heated, and quenched to reharden and temper them for reuse. A typical blacksmith shop included, at a minimum, a forge with

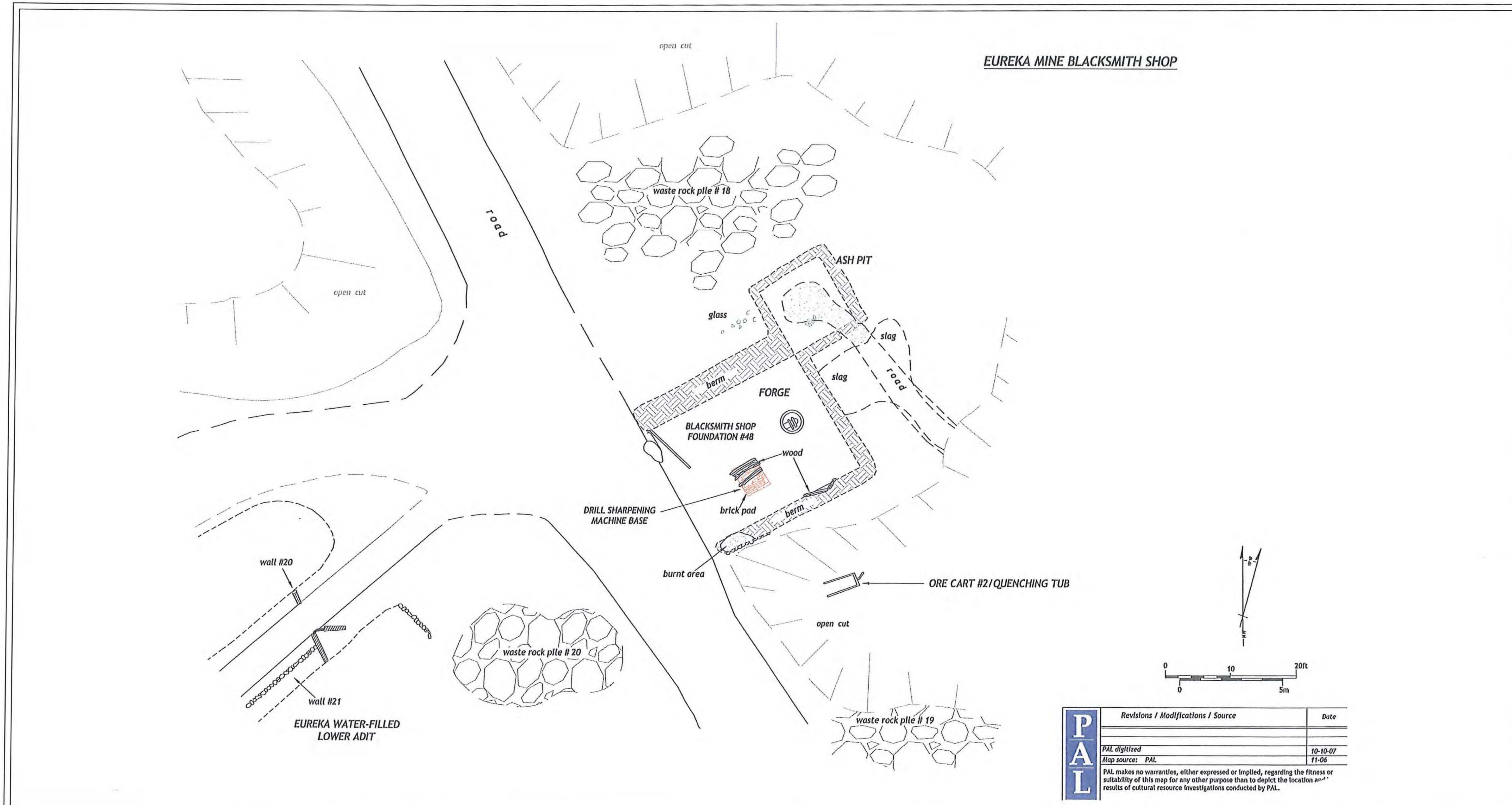

Figure 7-37. Detail plan of Eureka Mine Blacksmith Shop site.

Figure 7-38. Current photograph of Eureka Mine blacksmith forge, view looking east.

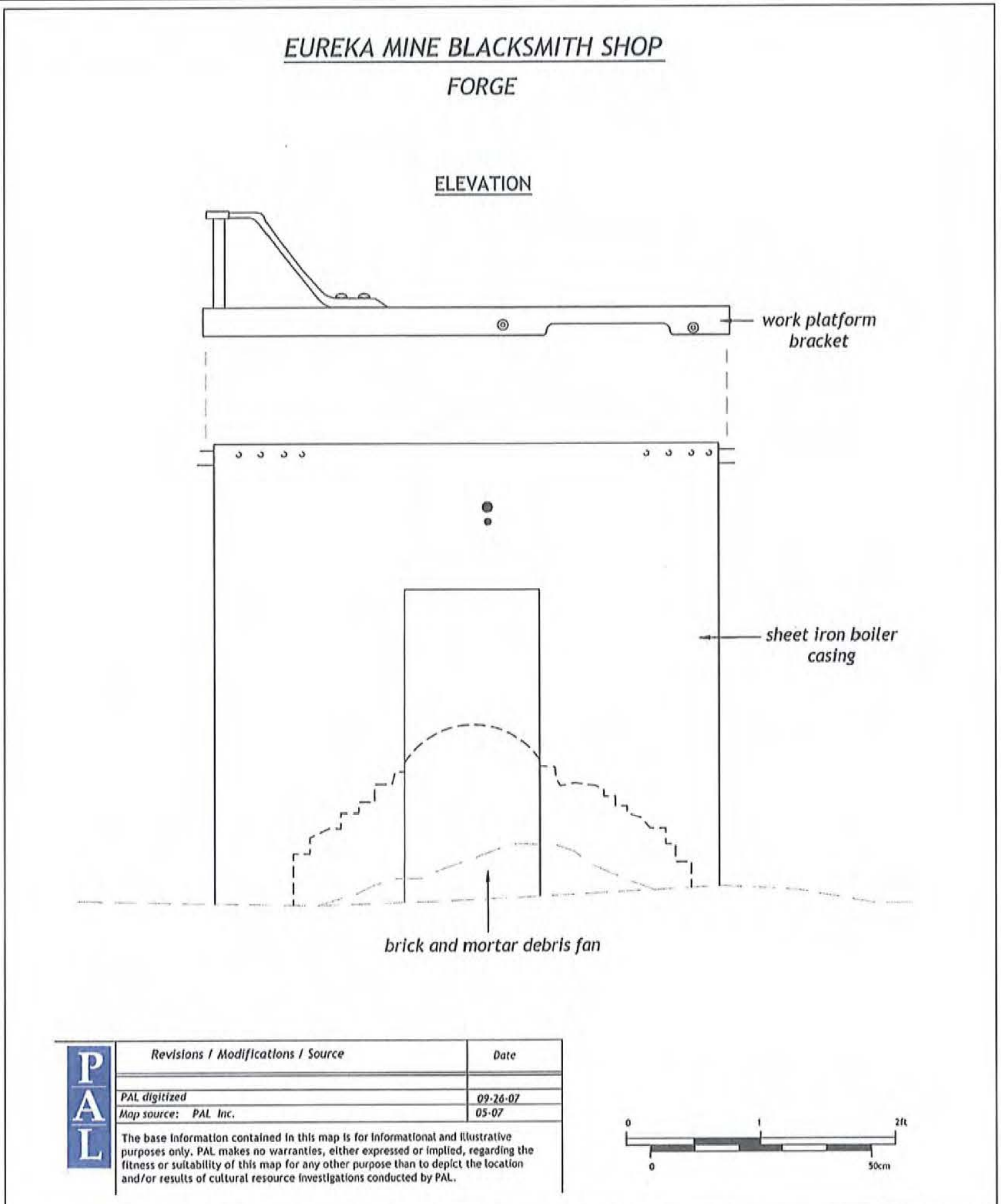

Figure 7-39. Detail elevation drawing of southwest elevation of Eureka Mine blacksmith forge.

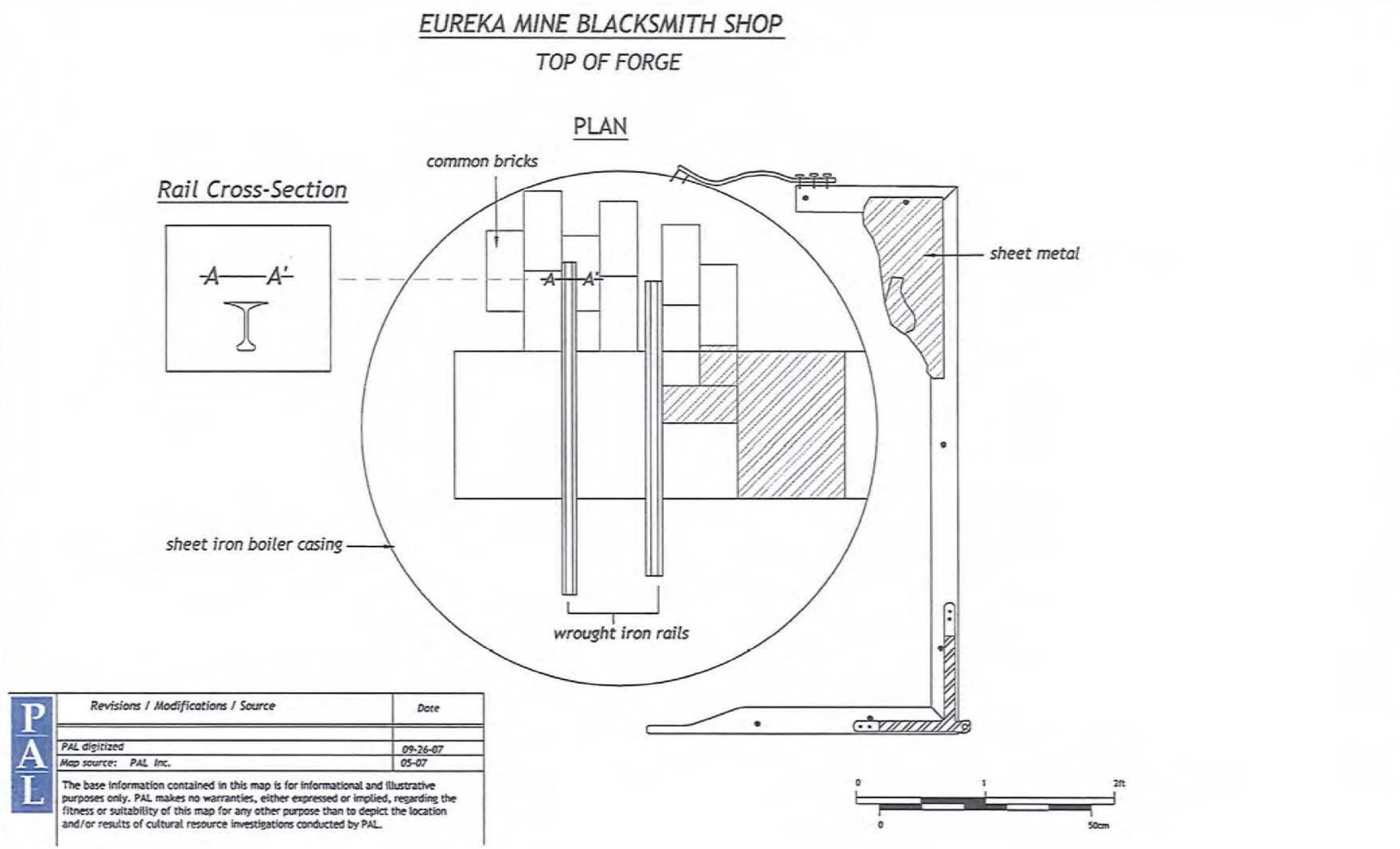

Figure 7-40. Detail plan drawing of Eureka Mine blacksmith forge.

blower, an anvil, and a quenching tank, as well as benches, vise, tool racks, etc. Figure 7-41 shows a typical blacksmith shop interior, including a cylindrical forge similar to the one at Pike Hill. (Twitty 2002:51–53).

Approximately 6 feet southwest of the forge is a square, 4 foot by 4 foot, brick pad with several deteriorated wood planks near its center and northwest side (Figure 7-42). The function of a typical mining blacksmith shop, the prominence, location, and size of this feature, and the presence of a quenching tub (see below) all indicate that this feature was the base for a drill sharpening machine. During the first decade of the twentieth century, mining machinery supply companies began to make machines for sharpening drill steels. By 1910 these machines had been reduced in size and cost, making them available to smaller mines. To compensate for vibrations these machines made, manufacturers recommended that they be bolted to timber footings over concrete (Twitty 2002:63–66). Figure 7-43 shows the floor plan of a small mining blacksmith shop excavated in Colorado. This floor plan closely resembles the configuration of the Eureka Mine blacksmith shop floor plan, with a round forge base and square drill sharpening machine base just in front of it. Figure 7-44 shows a Leyner-brand drill sharpening machine.

The north annex contains an approximately 7 foot diameter area of burnt material, which extends out through the possible doorway gap in the southeast side, and widens out into a an approximately 15 foot wide pile of coal ash and cinder. The function of the north annex is unknown. It may have been a room for a separate, smaller forge, however, Figure 5-11, which clearly shows the blacksmith shop, does not show a separate structure or addition to the building at this corner. This feature may have been a lower walled enclosure, possibly an outdoor forge ash bin or general shop dump area.

Ore Cart 2 is located approximately 20 feet east of Foundation 21 (Figure 7-45). It is a rectangular, sheet iron tub measuring 60 inches long, 30 inches wide, and 22 inches deep (Figure 7-46). The sides and bottom are riveted together, with a 2 inch strap riveted to the upper edge. Figure 7-47 is a technical illustration of a similar ore cart. The cart has been modified by removal of its undercarriage and installation of cast iron plumbing in one end. The modifications and proximity to the blacksmith's forge suggest strongly that this is a "continuous-flow" quenching tank for quickly cooling the heated ends of compressed air drill bits after sharpening to re-harden the steel. Using a tank of stagnant water for quenching was problematic as the water became hot and temperature fluctuations interfered with proper hardening and tempering. This was avoided by installing continuous-flow tanks, plumbed to maintain an even water temperature. Manufactured units were expensive, galvanized sheet iron units that contained at least 25 gallons of water, with inflow and drain lines (Twitty 2002:54-55). The Eureka Mine blacksmith, however, simply recycled an existing ore cart, saving the cost of a new unit. Ore Cart 1 is located at the west foot of Waste Rock Pile 15, and is of similar, although unaltered and more deteriorated condition, to Ore Cart 2.

Eureka Ore Mill Area

The Eureka Ore Mill Area is located at the northeast end of the Eureka Mine Subsite, northeast of Road 16 to the southeast, and Road 6 to the northeast. It is a steeply sloped, approximately 500 foot long northeast-southwest, approximately 300 foot wide area bisected by Road 15 and Road 2. The focal feature of this subsite is the foundations of the Eureka Ore Mill, an approximately 200 foot long northeast-southwest, approximately 75 foot wide linear complex of tiered foundations located at the

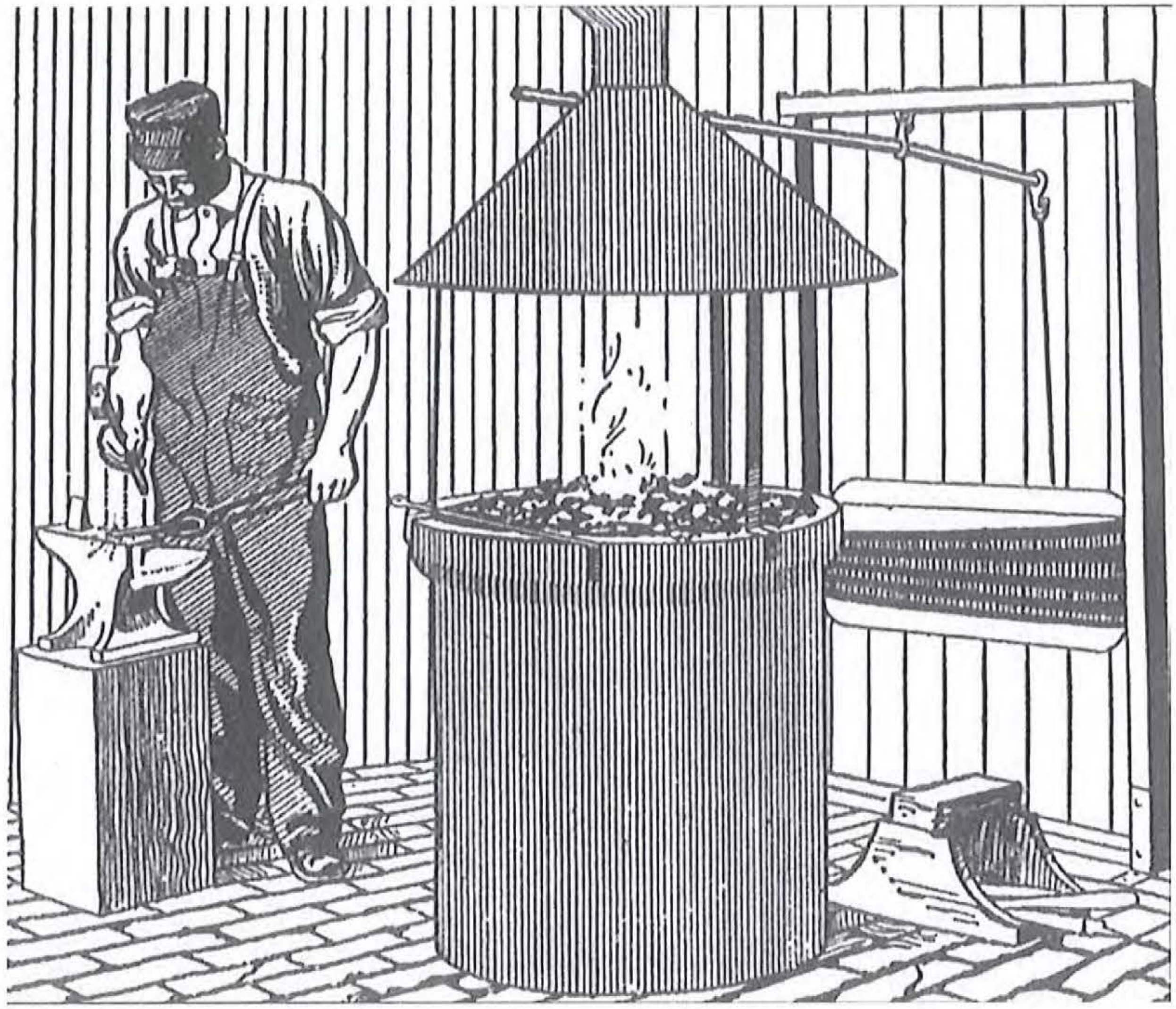

Figure 7-41. Illustration of typical mining blacksmith shop (source: Twitty 2002:51).

Figure 7-42. Current photograph of possible drill sharpening machine base, Eureka Mine blacksmith shop, view looking northeast.

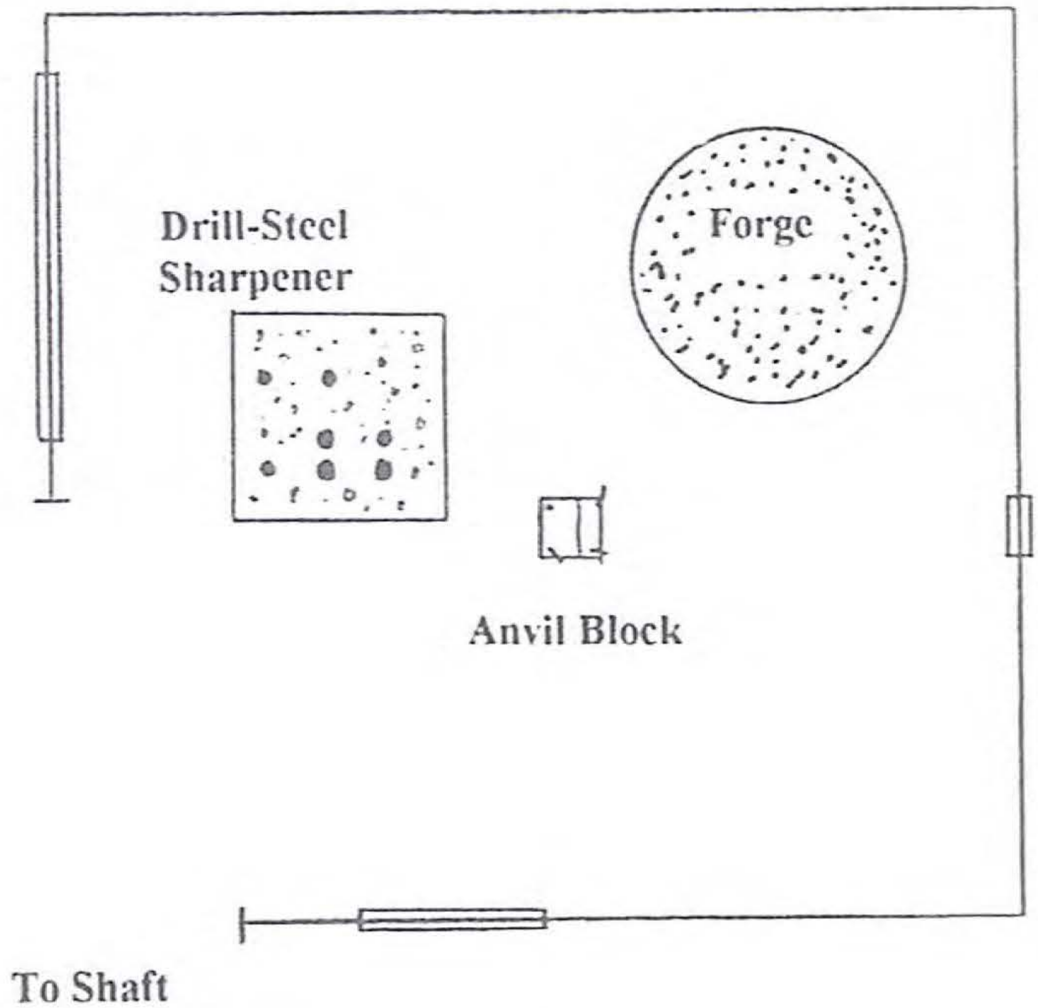

Figure 7-43. Archaeological plan of mining blacksmith shop (source: Twitty 2002:69).

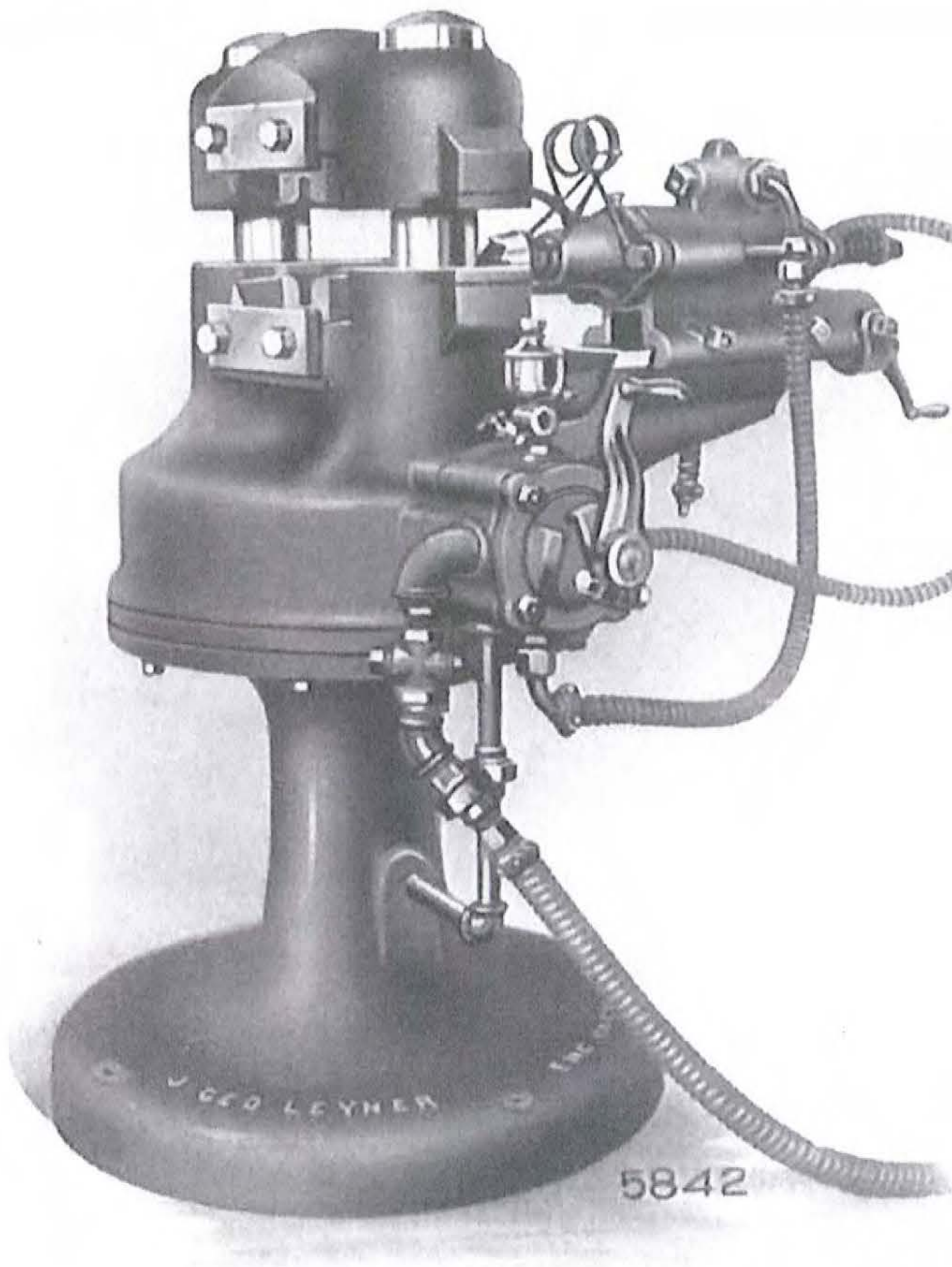

Figure 7-44. Illustration of a drill sharpening machine (source: Twitty 2002:65).

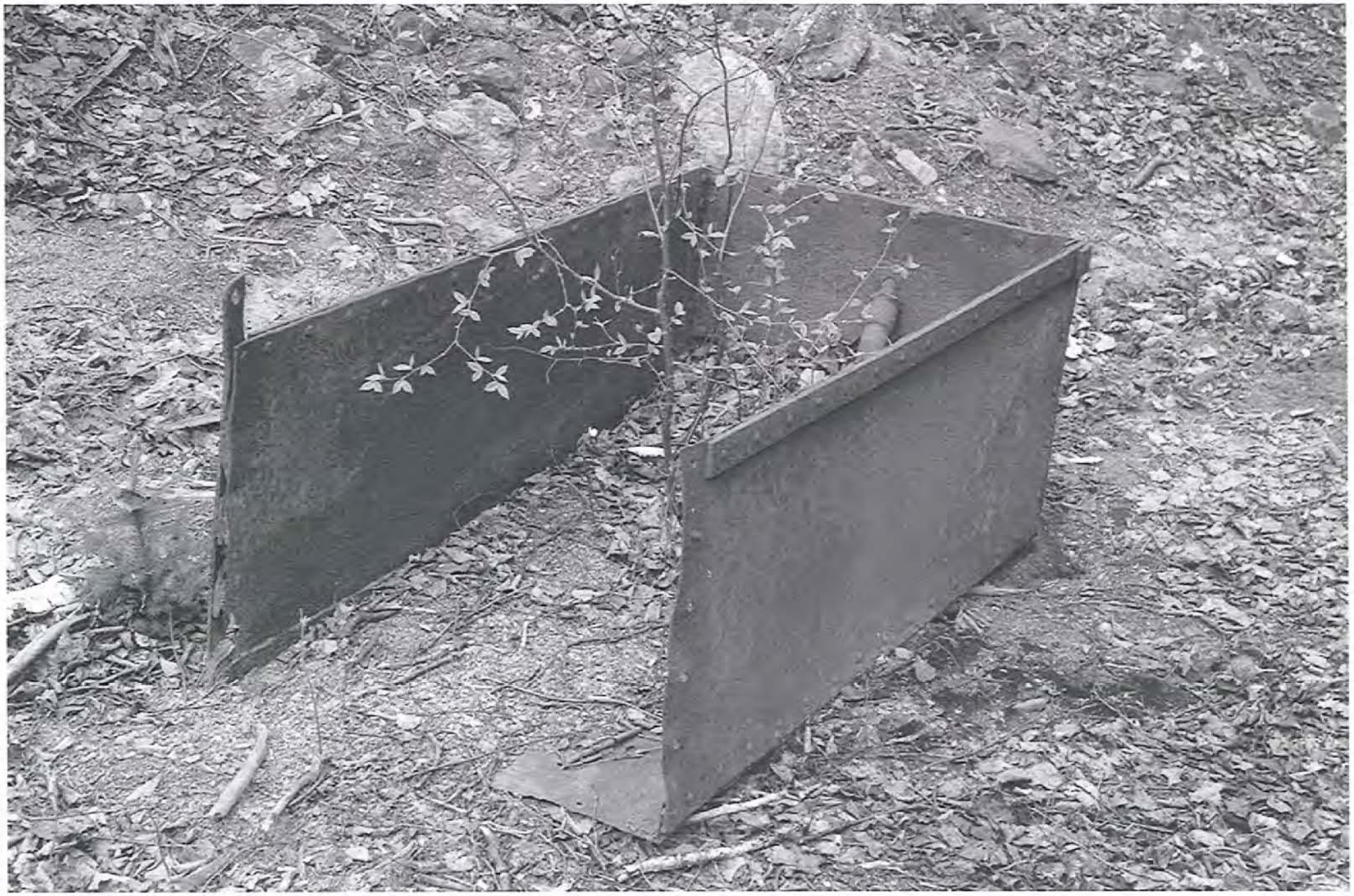

Figure 7-45. Current photograph of ore cart 2, view looking north.

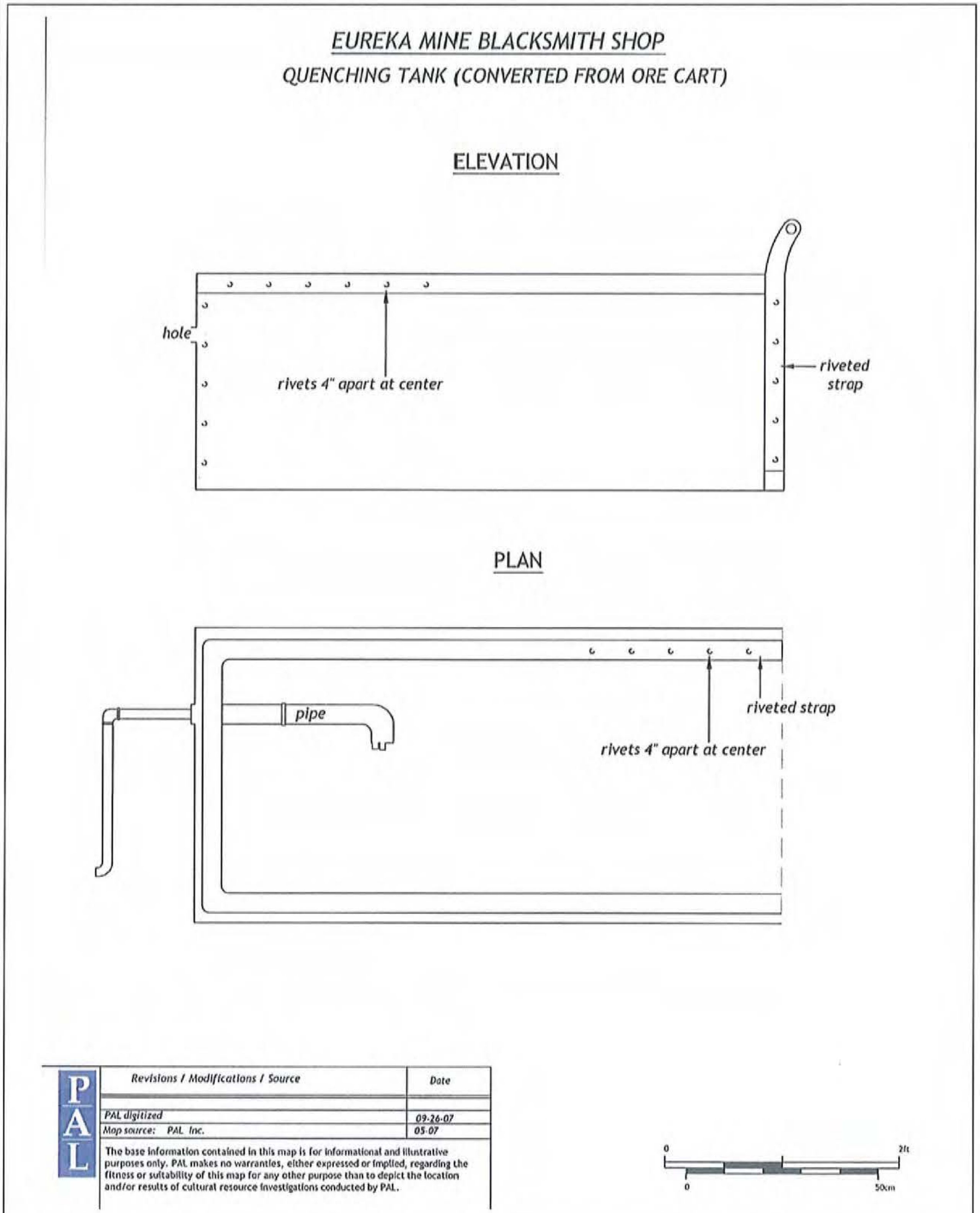

Figure 7-46. Detail drawing of ore cart 2.

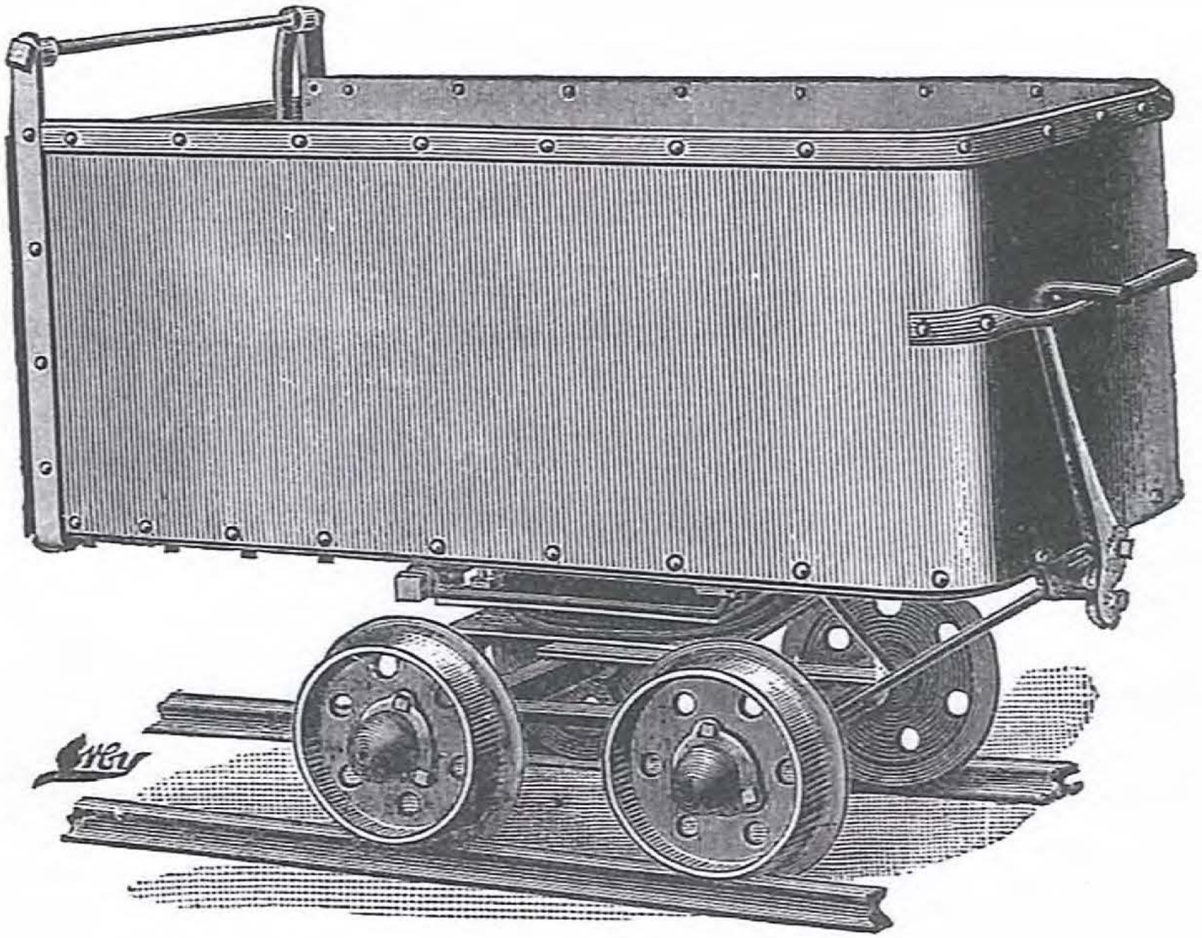

Figure 7-47. Illustration of an ore cart (source: Ihlseng 1898:153).

center of the subsite, north and west of Road 15, and southwest of Road 2. For clarity of description, the short end of the Ore Mill adjacent to Road 2 is the north end, the short end north of Waste Rock Pile 20 is the south end, etc.

Water Supply Features

Foundation 22 (upper reservoir) is located approximately 40 feet south of the south end of the Ore Mill (Figure 7-48). It is a rectangular, 75 foot long northwest-southeast by 27 foot wide, mortared schist block structure. It is divided into two compartments by a transverse wall, creating an approximately 50 foot long, larger section to the northwest, and a shorter, approximately 25 foot section to the southeast. The interior walls of the longer section are parged with a layer of concrete. Both sections hold water at their northeastern edges, and are partially filled with soil that has fallen over the uphill (southwest) wall. A length of 3 inch diameter cast-iron pipe is located in the northeast corner of the smaller section, and appears to be part of a siphon or drain. The size, location above the milling and powerhouse section of the Ore Mill, its mortared walls, and capacity to hold water indicate that that this structure was a primary reservoir for holding water for early-twentieth-century Ore Mill operations including power generation, first in steam boilers and later in a gas producer, and for process water for the ball mill and flotation cells. This structure was constructed ca. 1907 (Pike Hill Mines Co. Harry Hunter Letterbooks 1906–1907).

Foundation 23 (lower reservoir) is located approximately 60 feet northeast of Foundation 22, just west of Road 23, and approximately 20 feet southeast of the Ore Mill (Figure 7-49). It is a rectangular, 16 foot by 16 foot, mortared schist block structure filled with water of an undetermined depth. The location next to the powerhouse section of the Ore Mill, its mortared walls, and capacity to hold water indicate that it was a smaller, earlier reservoir for holding water for early-twentieth-century operations.

Ore Mill

The Eureka Mine Ore Mill is an approximately 200 foot long northeast-southwest, approximately 75 foot wide linear complex of tiered foundations (Figures 7-50, 7-51, 7-52, and 7-53). It is illustrated in several historical photographs dating from the early-twentieth-century operations at the Eureka Mine (see Figures 5-11, 5-12, and 7-7). This mill was constructed in 1905 for magnetic separation equipment, which operated from April 1906 to November 1907. Wood skin flotation process experiments were conducted between August and October 1915. The magnetic separation equipment was briefly resuscitated in 1916. Conventional froth flotation experiments were conducted from the summer of 1916 to April 1917. During the summer of 1917, the mill was extensively modified for a 100 ton per day froth flotation system, which operated from September or October, 1917 to spring of 1919. During the 1905–1907 campaign, the equipment was at first powered by a conventional stationary steam engine, and later, by a gas producer fueling two Otto internal combustion engines. These engines were connected to a dynamo or dynamos, and the electricity powered overhead motors connected to the machines by belt drives, and motors mounted directly to the machines. During the 1915–1919 campaigns, electricity was delivered to the site via transmission lines, and the mill equipment was driven by electric motors connected directly to the machines.

Figure 7-48. Current photograph of Eureka Ore Mill upper reservoir (Foundation 22), view looking southeast.

Figure 7-49. Current photograph of Eureka Ore Mill lower reservoir (Foundation 23), view looking southeast.

Figure 7-50. Current photograph of Eureka Ore Mill, general view looking east.

Figure 7-51. Current photograph of Eureka Ore Mill, general view looking southwest.

Figure 7-52. Current photograph of Eureka Ore Mill, general view looking southwest.

Figure 7-53. Current photograph of Eureka Ore Mill, general view looking northwest.

The Ore Mill can be divided into two main sections, the ore processing section, and the powerhouse section (Figure 7-54). The ore processing section is the much larger of the two, consisting of a north-south-oriented series of 10, tiered, attached, rectangular stone and concrete foundations measuring approximately 200 feet long north-south by from 25 to 45 feet in width east-west and ranging over 50 feet in relative floor elevation from top to bottom. The ore processing section contains machinery pads and piers, artifacts, and debris associated with the different ore processing campaigns and equipment. The powerhouse section is located at the southeast side of the milling section. It is smaller, measuring approximately 55 feet north-south by approximately 35 feet wide, ranging approximately 15 feet in relative elevation. It contains a cluster of rectangular foundations, platforms, and machine bases associated with power generation and transmission for the mill.

Ore Processing Section

The Ore Processing Section description is organized from north to south, from the upper elevation of the mill to the lower, following the gravity- and water-fed flow of the ore milling process. Each of the 10 tiered floor levels are described individually in sequence including dimensions, relative elevation, materials and machinery remains, waste materials, and artifacts. Each level is correlated with the sections of the building as shown in historical photographs (7-55). The description of each level is followed by an interpretation of the mill level in terms of its apparent function as indicated in the flow charts and process descriptions of both the 1906–1907 magnetic separation campaign and 1917–1919 flotation campaigns. Many of the features are consistent with the World War I flotation mill at the Ely Mine and similar small flotation mills elsewhere. Although the 1917 reconstruction was described as extensive, visible evidence of the earlier magnetic separation operation does survive.

Above Level 1, north of Waste Rock Pile 20, 20 feet south of the south end of the Ore Mill, is a 13 foot long, 2 foot wide concrete pad that served as a base for one of the timber bents that supported the ore trestle that connected the Lower Adit with Level 1 of the Ore Mill.

Level 1 is rectangular, measuring 28 feet north-south by 22 feet east-west. It has a concrete slab floor, and raised concrete sills ranging from 12 to 18 inches in width with 7/8th inch diameter threaded vertical steel pins for wood sills, no longer extant. The concrete sills incorporate sections of worn, light-gauge mine car rail for reinforcing bars. The north half of this floor level was located under mill building section "A" as indicated in Figure 7-55. The south half was located under the north end of building section "B," where the open doorway and top of the conical Waste Rock Pile 10 are shown in Figure 7-7. Level 1 is the location of the ore bin, described as having a capacity of 800 tons during the 1917–1919 campaign. Ore was trammed to the end of the curved tramway, dumped into an inclined chute and stored inside building section "A" in the heavy timber cribbed bin with an inclined floor sloping down to the south, from which it was drawn from a chute to fall to the next level of the mill.

Level 2 is rectangular, measuring 14 feet north-south by 24 feet east west. The floor is 10 feet below Level 1, and covered with soil. The bulk of the floor area is occupied by a deteriorated, tall concrete and mortared brick pier that has broken into several pieces lying to the west and south. Two 1½-inch diameter threaded vertical steel pins extend from the top of the pier, which is located immediately below the center of the north wall of the ore bin level above. Additional pins protrude from the fallen pieces of the pier. This level of the mill was located under the north part of building section "B," and was the location of the primary crusher, which sat on top of the partially collapsed pier. Ore drawn by gravity from

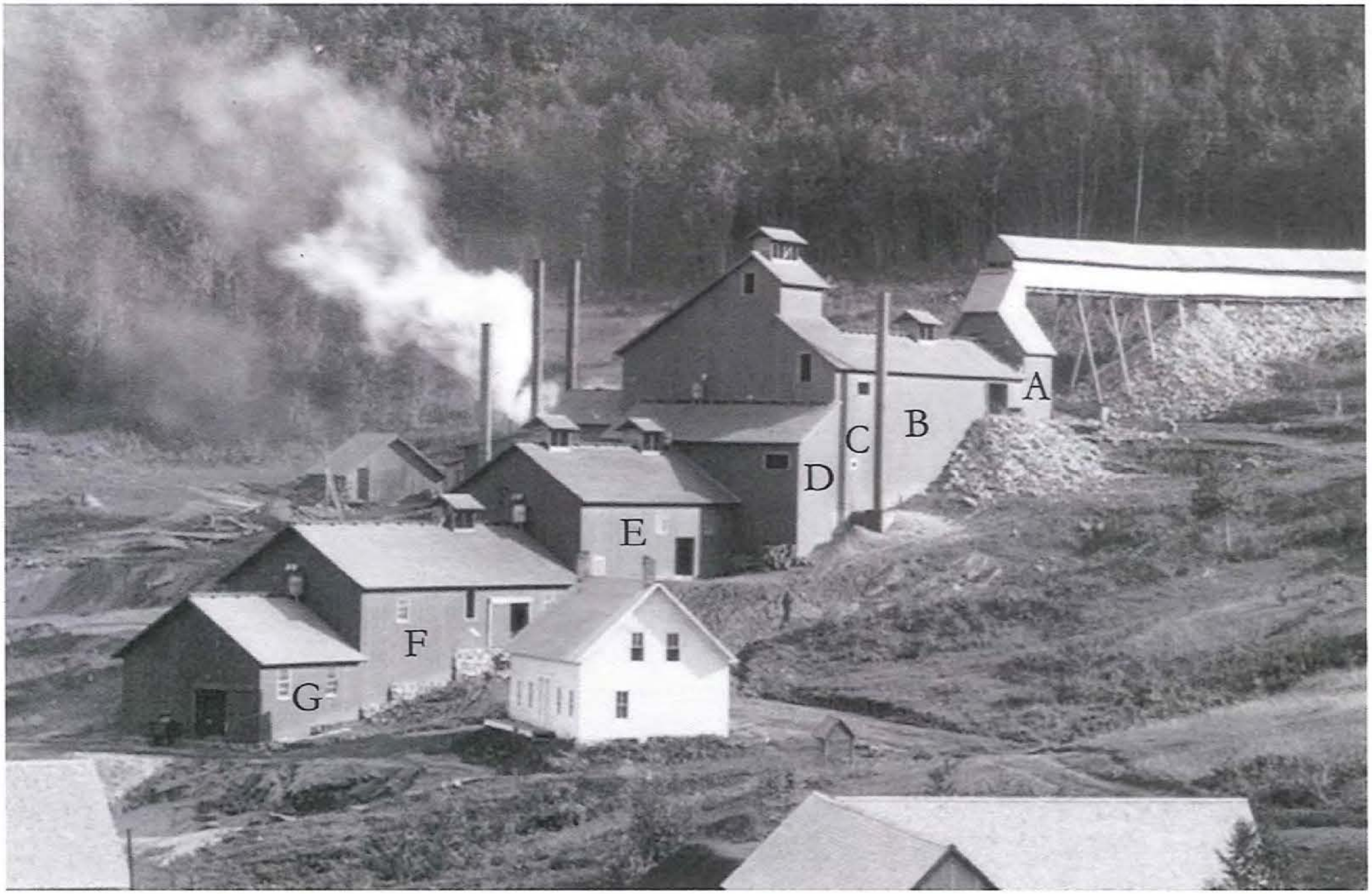

Figure 7-55. Annotated photograph showing Eureka Ore Mill building sections (source: http://www.uvm.edu/landscape//).

the storage bin above was fed through a Blake jaw-type crusher unit, identified as a 9½-inch by 16 inch unit during the 1906–1907 magnetic separation campaign, and as a 9-x-15-inch Sturtevant unit during the 1917–1919 flotation campaign (Pike Hill Mines Co. December 6, 1906 Flow Sheet of Crushing Mill; Jacobs 1918:145–146). The crusher mouth pass size for the crushed ore during these campaigns is unknown.

Level 3 is rectangular, measuring 27 feet north-south by 45 feet east-west. The floor is 5 feet below Level 2, and covered with soil. The floor is divided into two sections for descriptive purposes by an east-west line. Level 3a to the north and Level 3b to the south were located inside the south part of building section "B" as indicated in Figure 7-54. Level 3a contains an east-west row of deteriorated rectangular machinery bases. The bases are a combination of mortared brick and stone, with some surviving horizontal shock absorber timbers remaining. The machine bases appear to be divided into four clusters of vertical threaded steel machine mounting pins of ½ inch, ¾ inch, and 1 inch diameters, totaling 22 pins. The pad to the east is integrated into the wall between the ore processing and powerhouse sections of the Ore Mill. Level 3b immediately to the north is dominated by three massive rectangular mortared brick and concrete machinery piers. From west to east, the first, 5 feet west of the west wall, is a 9 foot by 7 foot pier with four, 1½ -inch diameter vertical threaded steel machine mounting pins (Figure 7-56). Eight feet to the east is the second pier, a 6 foot by 9 foot structure with two, 1½ inch pins. Four feet to the east is the third pier, a 12 foot by 6 foot structure with a complex upper surface incorporating 1½-inch and 1-¼-inch pins and a molded concrete 3 foot by 7 foot drain at its center (Figure 7-57).

The association of the machine bases in Level 3a is unclear. During the 1906–1907 campaign, the secondary crushing and screening circuit was complex, incorporating a picking belt, ¾ inch screens (likely trommels), 12 inch by 24 inch corrugated roll crushers, screw conveyors, an elevator, and a series of screens for 1/8th inch, #20 mesh, #10 mesh sorting, and a second, 14 inch by 30 inch roll crusher, and fine and coarse product storage bins (see Figure 6-5, Pike Hill Mines Co. December 6, 1906 Flow Sheet of Crushing Mill). This complex circuit was located above Level 6 (building section "E"), which contains evidence for location of the magnetic separation and associated roasting machines. This would have placed the secondary crushing and screening circuit on Level 3 and Level 4, under building sections "B," and also likely under Sections "C" and possibly "D." During the 1917–1919 campaign, the crushed ore from the bottom of the jaw crusher on Level 2 was taken by a belt elevator directly to the 100-ton capacity ore bin, which was high above Level 4 in building section "C" (Jacobs 1918:145–146). This would have simply required an electric motor and a vertical or inclined conveyor that would have bridged the area of Level 3a. The machinery pads in Level 3a may be for the 1906–1907 campaign trommels and roll crusher, machinery types that typically occupied rectangular footprints similar to those of the Level 3a machinery bases. These bases could have simply been left in place during the 1917 reconstruction, or could be associated with unknown equipment from the 1917–1919 campaign. The three bases on Level 3b are clearly consistent with the pads for ball mill bearings, drive gear, and outflow drain, and are where the 6 foot by 22 inch Hardinge ball mill for the 1917–1919 was mounted.

Level 4 is rectangular, measuring 8 feet north-south by 42 feet east-west. The floor is 5 feet below Level 3, and covered with soil. This level was located in building section "C," which had an unusual elevated, irregular gable roof configuration. This section of the Ore Mill contained the second ore storage bin. During the 1906–1907 campaign, the mill had a divided bin for the #20 and #10 mesh feed to the first magnetic separation machine. During the 1917–1919 campaign, the mill had an elevated 100 ton bin for the #60 mesh material from the Hardinge ball mill (Pike Hill Mines Co. December 6, 1906 Flow Sheet of Crushing Mill; Jacobs 1918:145–146). The ore bin would have been a tall structure constructed of heavy timbers and planks, protected by the outer skin of building section "C."

Figure 7-56. Current photograph showing Eureka Ore Mill Hardinge ball mill pier and mounting pins, view looking north.

Figure 7-57. Current photograph showing Eureka Ore Mill Hardinge ball mill pier with drain, view looking southwest.

Level 5 is rectangular, measuring 12 feet north-south by 40 feet east-west. The floor is 5 feet below Level 4 and covered with soil. This level is located under building section “D” in 7-54. This level is divided into east and west sections by a tall, 3 foot wide, partial transverse mortared brick and concrete machine pier that extends 6 feet north from the south wall, and incorporates a 1½-inch diameter threaded vertical steel machinery pin. Three feet to the west is a 6 foot long north-south, 1 foot wide, low concrete pad with two 1-inch diameter threaded vertical steel machinery pins. Five feet to the west is a set of three, 1 foot square, low, concrete machinery piers, each with a single, 1-inch diameter, vertical threaded steel machinery pin. The three pads are arranged in a square pattern, suggesting that a fourth pad to the southwest may be buried or missing. The association of this level is unclear. During the 1906–1907 campaign it may have housed equipment associated with the later stages of the crushing circuit. During the 1917–1919 flotation campaign, the #60 ground ore from the 100 ton bin in Level 4 was gravity fed to two, 2-pocket Richards classifiers, with the oversize material sent back to the Hardinge ball mill via a Frenier pump, and the undersize material proceeding to the 10-comparment flotation cell. During the 1917–1919 campaign, Level 5 may have housed the Richards classifiers, Frenier pump, or additional undocumented equipment.

Level 6 is rectangular, measuring 30 feet north-south by 24 feet east-west. It is the first of the narrower sections of the mill extending north from the wider, upper levels. This level was located under building section “E.” The floor is 5 feet lower than Level 5. It has a visible concrete slab floor. There is a shallow, 6 foot by 6 foot, square pit or drain located toward the northeast corner. The north edge of the floor is covered in a thick deposit of reddish brown, fine, metallic powder that has been fused into a hard mass. This material extends north in a thick fan into the north end of Level 7, and appears to be sintered fines from an ore roasting process, which would place it in the 1906–1907 campaign. Following the 1906–1907 process flow, the step following the ore bin would have been passage of the finely ground ore through the first of two Wetherill magnetic separators to separate the magnetic pyrrhotite from the non-magnetic chalcopyrite and gangue. Then the chalcopyrite and gangue were roasted to magnetize the chalcopyrite for a pass through a second magnetic separator (Gunther 1909:15). This would logically place the first magnetic separator, the “pyrrhotite machine,” on the next mill level, Level 6, or at its southern end, with the roasting likely taking place at its eastern end, or on Level 7 below. During the 1917–1919 flotation campaign, logic dictates that the 10-compartment Mineral Separation Company flotation cell would be located on Level 6, the next large level below the ore bin at Level 4.

Level 7 is rectangular, measuring 50 feet north-south by 24 feet east-west. It is the second of the narrower sections of the mill extending north from the wider, upper levels. This level was located under building section “F.” The floor is 10 feet lower than Level 6. It has a concrete slab floor under a layer of soil, sinter, and masonry refractory materials. The southern third of the floor consists of a thick fan of ore sinter that rises up to the north edge of Level 6. Two deteriorated mortared brick machinery pads are located at the middle of the floor, just east of center. The south pad incorporates two, ¾-inch diameter threaded vertical steel machinery pins, and the north pad two similar pins of 1-inch diameter. Immediately north is a 15 foot diameter pile of broken concrete, brick, and specialty-shape refractory bricks (Figure 7-58). At the east edge of the floor is a 42-inch diameter riveted sheet iron cylinder, resembling a boiler shell, lined with mortared common brick; and a flattened section of riveted sheet iron smokestack (Figure 7-59). Also in this location is a segmental-arched cast-iron furnace door frame with a thick encrustation of the rusty sinter around its inside face (Figure 7-60). The remains on this level strongly suggest that it is the location of the ore roaster associated with the 1906–1907 magnetic separation campaign, and, because of its size, possibly the second Wetherill magnetic separator, the “chalcopyrite machine,” that separated the chalcopyrite that was magnetized in the roaster from the non-

Figure 7-58. Current photograph showing refractory materials at Level 7, Eureka Ore Mill, looking southeast.

Figure 7-59. Current photograph showing boiler shell and smokestack section, Eureka Ore Mill level 7, view looking south.

Figure 7-60. Current photograph showing possible ore roasting furnace door, Eureka Ore Mill level 7, view looking south.

magnetic quartz-mica gangue. During the 1917–1919 flotation campaign, this level may have held the "settling tank," possibly a Dorr-type thickener, for thickening the chalcopyrite concentrate from the flotation cells, and possibly the 6 foot diameter Oliver drum filter for dewatering the concentrate for packing and shipment (Jacobs 1918:145–146).

Level 8 is rectangular, measuring 13 feet north-south by 24 feet east-west. It is the third of the narrower sections of the mill extending north from the wider, upper levels. This level was located under building section "F." The floor is 5 feet lower than Level 7. It has a concrete slab floor under a layer of soil. There are no machinery remains visible at this level. During the 1906–1907 magnetic separation campaign this level could have housed the second Wetherill magnetic separator, or "chalcopyrite machine." During the 1917–1919 flotation campaign, it could have housed the Oliver drum filter.

Level 9 is rectangular, measuring 11 feet north-south by 24 feet east-west. It is the fourth of the narrower sections of the mill extending north from the wider, upper levels. This level was located under building section "G." The floor is 5 feet lower than Level 8. This section of the building was likely used for chalcopyrite concentrate storage during the 1906–1907 and 1917–1919 milling campaigns.

Level 10 is rectangular, measuring 10 feet north-south by 24 feet east-west. It is the fifth and last of the narrower sections of the mill extending north from the wider, upper levels (Figure 7-61). This level was located under building section "G." The floor is 2.5 feet lower than Level 9. This level has a 1 foot thick perimeter concrete sill, with a 6 foot by 8 foot extension on its north side. This foundation has rectangular pockets for timbers on the inside faces, possibly for supporting a small indoor overhead concentrate storage bin for chalcopyrite concentrates from the 1906–1907 and 1917–1919 milling campaigns.

Powerhouse Section

The powerhouse section contains four level rectangular concrete slab floor platforms, some containing machinery bases or other features.

The southernmost of these platforms is located immediately southeast of the southeast corner of the Ore Mill processing section Level 2. It is a 16 foot long north-south by 20 foot wide east-west concrete platform at the same elevation as adjacent Level 2. It contains two concrete pads at its center, approximately 3 feet apart (Figure 7-62). Each pad measures 12 feet long north-south by 3 feet wide east-west, and each pad supports a 10 foot long by 2 foot wide mortared brick pier. Each pier has two parallel rows of three, 1¼-inch diameter threaded vertical steel machinery mounting pins extending from the top surface. These piers may have supported the two Otto engines or the dynamo from the 1906–1907 magnetic separation campaign. A short section of charred plank wall is located in the earth immediately north of the piers, and may be a remaining fragment of the powerhouse outer wall.

Six feet north of the previous pad, 8 feet east of ore processing section Level 3a, is another concrete pad, 5 feet below the one just described to the south. It is a 4 foot wide north-south by 12 foot long east-west pad, with a 3 foot wide, 10 foot long deteriorated brick pier containing several dislodged and one in situ 1-inch diameter threaded steel machine pins. The location suggests that it could have been a base for a motor that drove the row of unidentified machines in adjacent ore processing Level 3a to the west.

Figure 7-61. Current photograph showing concrete foundations at Eureka Ore Mill level 10, looking southeast.

Figure 7-62. Current photograph showing machinery pads, Eureka Ore Mill powerhouse section, view looking southeast.

East of the previous feature are two 5 foot diameter circles of burned specialty-shape curved and wedge-shaped refractory brick, as well as some scattered, curved and wedge-shaped pieces of similar brick. One circle is 5 feet southeast of the previous feature, and the other is 10 feet to the east. The materials and location correspond to the bases of the two tall sheet iron smokestacks shown in Figures 5-12 and 13, and these features are likely the bases for the two smokestacks for the boilers and/or gas producer.

Immediately west of ore processing Level 3b and Level 4 is a 24 foot long north-south by 13 foot wide east-west concrete slab platform. At the south end is a U-shaped, brick pier with walls 2 to 3 feet wide, with six, ¾-inch diameter vertical threaded steel machine pins at its south end. A second cluster of similar pins arranged in a rectangular pattern is located 10 feet north at the opposite end of the concrete platform. The function of this platform and pier are unknown.

Immediately east of the previous platform is another concrete platform, measuring 14 feet by 14 feet square. A thin scatter of beehive oven type coke approximately 6 feet wide extends from the center of this platform north for approximately 30 feet. Four feet to the east is a 13 foot long north-south by 18 inch wide mortared brick wall. This platform and wall may have been associated with a fuel storage room for the gas producer or boilers.

The features in the powerhouse section are more difficult to interpret. The area occupied is much smaller, reducing the potential for remains of the early boiler and steam engine that reportedly powered the mill in its earliest operations after construction in 1905, as the piers for that equipment may have been removed sometime after installation of the gas producer and Otto engines that followed steam power in 1906–1907. The 1917–1919 flotation campaign was powered by electricity brought in from off site, which was stepped down to 440 volts, and distributed to individual motors to drive the machines. Some of the older machines may have been driven via lineshafting and belts, but it is very likely that the newer, heavier machinery installed as part of the 1917 reconstruction were driven by motors mounted directly to the machines. This direct drive electrical transmission system would have largely bypassed the powerhouse, only requiring installation of new transformers and switchgear. This may have preserved some of the gas producer/Otto engine/dynamo internal combustion-powered equipment from the later part of the 1906–1907 magnetic separation campaign. It is likely that some sort of small boiler for heating water was part of the equipment for both campaigns. Unfortunately, there is a lack of primary and secondary information and archaeological documentation regarding the configuration and spatial relationships of Otto engines, gas producers, and dynamos, especially at small ore processing mills, and the configuration of the machinery bases that were constructed to support them. The interpretations for these machinery bases within the powerhouse section of the Ore Mill are therefore more speculative.

Waste Materials

Waste Rock Pile 20 is located at the southwest end of the subsite, approximately 25 feet southwest of the south end of the Ore Mill. It is an approximately 100 foot long southwest-northeast, approximately 30 foot wide, curving, flat-topped pile of vegetated waste rock that was deposited to provide an embankment for a portion of the approximately 400 foot long, curving, covered ore tramway shed that extended from the Lower Adit portal wall to the Ore Mill ore storage bin at Level 1. The waste rock pile and tram shed are clearly visible in Figure 7-7.

Waste Rock Pile 10 is located immediately northwest of the ore bin and crusher sections of the Ore Mill, and is clearly visible in Figure 7-7. It is a flat-topped, conical pile of vegetated waste rock that was deposited to provide a platform for the ore storage bin and primary crusher level of the Ore Mill. As shown in Figure 7-7, its northwest end is clearly located outside a wide door in the northwest elevation of the primary crusher level of the Ore Mill. Waste Rock Pile 10 may, in this area, also contain materials removed from the process flow at the primary crushing stage such as poor ore, materials that jammed the crusher jaws, etc.

Immediately west of Level 6 and Level 7 of the Ore Mill is an approximately 75 foot diameter oval area of reddish brown waste material. The color and proximity of this material to Level 6 and Level 7, where the roasting furnaces for the magnetic separation process appear to have been located, suggest that this are is a dump for the sinter material also found within the adjacent Ore Mill foundation levels.

The area immediately north, northeast, and east of the Ore Mill is occupied by an open area of finely ground processed mineral waste characterized by steep eroded gullies, and areas of different textures and colors. The tailings area is approximately 300 feet wide east-west, to anywhere from 50 to 150 feet wide north-south. Road 2 crosses the upper part of the tailings area, entering it from the northwest near Foundation 42, passing immediately north of the Ore Mill, and exiting it to the east at the junction of Road 16. The tailings have eroded, been encroached upon by vegetation, and disturbed, altering their original extent and appearance. It appears that a portion of the tailings has washed downhill into the woods to the southeast. The tailings lie in four major northeastward-pointing lobes, with areas that exhibit different distinct characteristics that identify them as products of the magnetic separation and flotation campaigns and late-twentieth-century disturbance. The overall character of the tailings reflects the fine ground gangue (waste rock) and non-copper-bearing pyrrhotite discarded from the 1917–1919 flotation campaign. This material is a fine yellow powder that extends throughout the tailings area. Several deeply eroded gullies northeast of the Ore Mill and across Road 2 contain wood planks and poles that appear to be buried elements of stabilization structures for the tailings pile, a feature seen at the much bigger Tailings Pile 1 at the Elizabeth Mine. The extent of the stabilization structures is unknown; it is likely that they are not extensive, as the flotation campaign at Pike Hill, like that during World War I at the Ely Mine, was short, and tailings disposal was relatively unsophisticated.

The two major lobes of the tailings area to the west are of a different appearance. These lobes contain a coarser, gray, sandy material that underlies and extends north of the yellow flotation tailings (Figure 7-63). This material is non-metallic, non-sulfidic, and consists mostly of roasted quartz and mica that was extracted from the ore during the 1906–1907 magnetic separation campaign. The cores of the two lobes of flotation tailings to the east, either side of Road 2, are a deep red color, with areas of whitish discoloration (Figure 7-64). This phenomenon is characteristic of roasted sulfide ore, and indicates the areas where the tailings were spontaneously combusting in 1983. These tailings were apparently disturbed in efforts to extinguish the fire; the extent of that disturbance is unknown.

Foundation 42, the Eureka Mine Office, is located approximately 50 feet northwest of the Ore Mill. Although it is technically within the Eureka Ore Mill Subsite, it is discussed in Chapter 8.

Prospect Trenches Subsite

The Prospect Trenches Subsite is a 38.2-acre area located on the south side of Pike Hill (see Appendix B). It is located immediately south of the Eureka Mine Subsite, and it hooks around the west side of the Smith Mine Subsite near its south end. It is approximately 2,600 ft long on its long, north-south axis, and varies in east-west width from approximately 1,100 ft wide at its north end, to approximately 250 ft wide where it passes the west side of the Smith Mine. The subsite contains 33 shallow trenches (Prospect

Figure 7-63. Current photograph showing Eureka Ore Mill magnetic separation tailings, view looking southwest.

Figure 7-64. Current photograph showing Eureka Ore Mill flotation tailings, view looking southeast.

Trenches 1, 3–6, and 8–35) varying in length from 350 feet to 20 feet, with most 50 to 100 feet long. The trenches are oriented roughly east-west, displaying an obvious attempt to cut across and intersect the projected strike of the ore bed along the surface. They begin at the north end of the subsite with a 350 ft long trench that curves around the south end of the “hook” in the south end of the Eureka Mine Subsite open cut 1. The trenches then trend southeast for approximately 800 feet in a band containing two more 350 ft long trenches, ending in a band of several shorter ones. A band of smaller, less closely clustered trenches then extends south-southwest to the Smith Mine Subsite. A band of six medium-length trenches is located south of the Smith Mine Subsite. The trenches vary in appearance from shallow wooded depressions in the earth to more significant excavations to bedrock, with piles of earth overburden and excavated rusty schist and quartz bedrock.

According to historical accounts discussed in Chapter 5, in 1846, Isaac Barbour and Charles Allen dug a series of prospect pits from the exposure of ore they were mining (now known as the Smith Mine) all the way to the top of the hill, just missing the exposure of the orebody subsequently mined by the Corinth Copper Company, first at the surface, then later by the Cuprum Shaft (Abbott *GMC* 1964:5–6, 46, 289; Whitney 1854:314). Some of these prospect trenches may be visible remnants of Barbour and Allen’s exploratory activities. However, the length (350 ft in some cases) of some of the trenches suggests they may have been dug later with excavation equipment. In 1944, almost 100 years after Barbour and Allen’s prospecting, the U.S. Geological Survey did exploration work at Pike Hill consisting of diamond drilling in the vicinity of the deposit. The USGS noted the prospect trenches, reporting that “These have all caved and slumped, and only a few exposures of bedrock remain.” The USGS also reported that “The disposition of the trenches shows a keen understanding of the [geological] structure of the area” (White and Eric 1944:28). It is possible that some of the larger trenches date from the 1907–1913 era prospecting and mining activities of E.L. Smith’s Corinth Copper Company, when larger, mechanized excavation equipment was available, and the understanding of the rock structure of the area was more informed by previous mining and exploration activity.

One test pit, JTP 28, was excavated in this subsite, northeast of Prospect Trench 34. No cultural materials were recovered in this test pit. This test pit contained backfill (dark brown 7.5 YR 2.5/2 silty sand) from the exploration trench to the limit of hand testing at 77 cmbs (Figure 7-65a).

Smith Mine Subsite

The Smith Mine Subsite is a 5.5-acre area located on the south side of Pike Hill (see Appendix B). It is located east of and near the south end of the Prospect Trenches Subsite, which hooks around it to the west and south. It is an oval-shaped area, approximately 700 feet wide on its long, east-west axis, and measures approximately 400 ft wide north-south. The site is accessed from the northeast by Road 17, which extends from Coppermine Road, off Richardson Road. The subsite contains several features associated with underground mining. The Smith Shaft is located near the center, and consists of an approximately 20 ft wide bedrock excavation that plunges northeast at a steep angle into an area of overhanging and collapsed rock (7-66). An approximately 50 foot diameter pile of broken rock that is relatively devoid of sulfide mineralization is located immediately south of the shaft. This material appears to be development rock associated with sinking the shaft and developing the underground workings. This pile of barren rock has a flat top, and contains some brick scatter that may be associated with a small structure, or the base of a small hoist, possibly a gasoline-operated unit like the one that appears to have been used at the Eureka Mine Cuprum Shaft during World War I-era operations. The now-collapsed mine adit is located approximately 50 ft east of the shaft, and consists of an approximately 50 ft long east-west-oriented, watered trench.

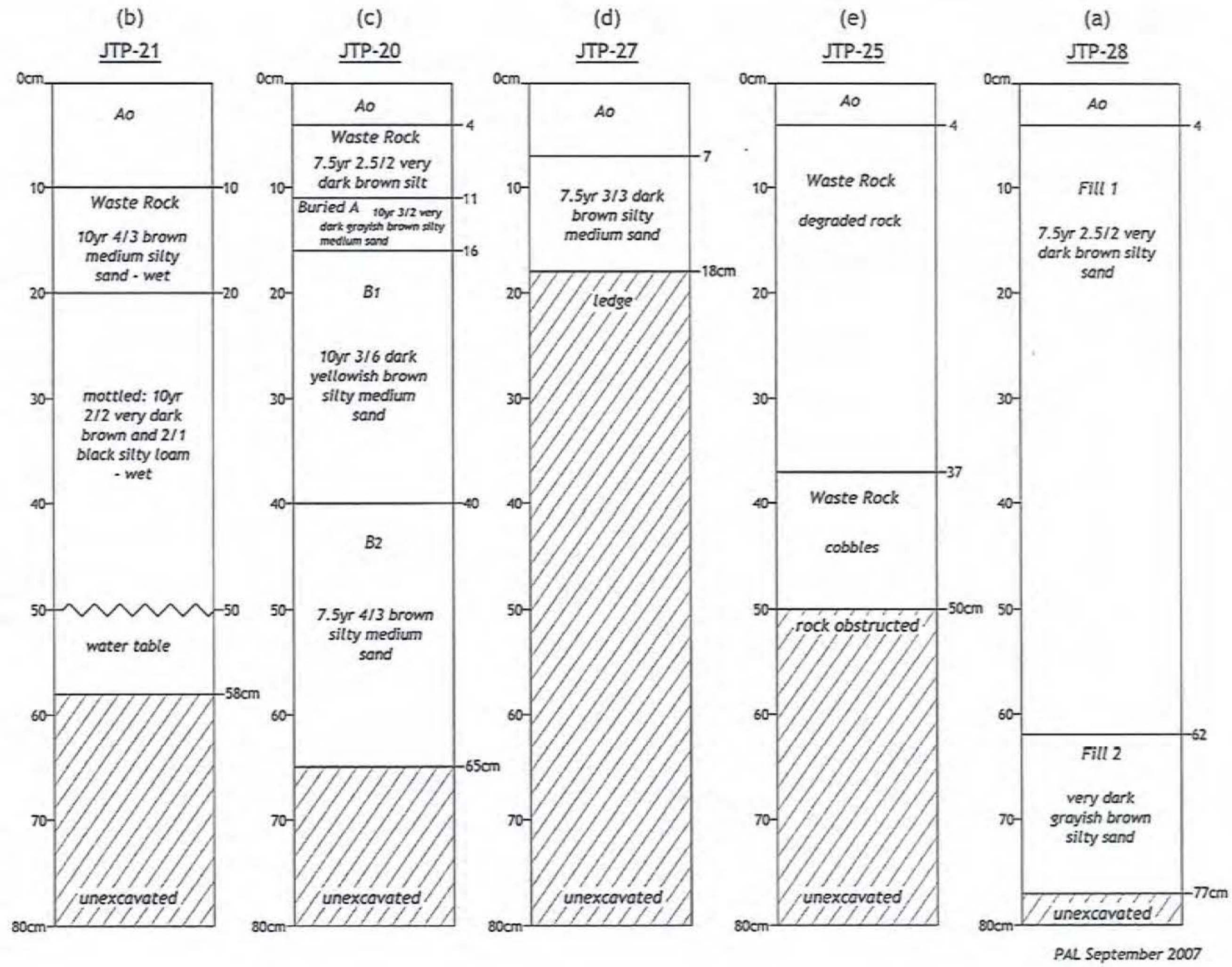

Figure 7-65. Representative test pit profiles in the Smith Mine Subsite.

Figure 7-66. Current photograph showing Smith Mine shaft, view looking north.

Foundation 10 lies immediately southeast of the end of the adit and consists of a 25 foot by 20 foot schist slab and cement structure. The function of this structure is unknown. Immediately east of the adit and Foundation 10 is Waste Rock Pile 38, which is an oval, approximately 100 foot long by 75 foot wide, conical pile of yellow weathered pyrrhotite ore. A second rectangular structure, Foundation 11, is located approximately 75 feet north of the Smith Mine Shaft. It consists of a 25 foot by 18 foot dry-laid schist structure. This feature is filled with water and may have been used as a reservoir for a crude ore washing operation.

The Smith Mine was the scene of the earliest mining activity on Pike Hill. Isaac Barbour and Charles Allen dug some ore and shipped it offsite to be smelted in 1846 (Abbott *GMC* 1964:5–6, 46, 289; Whitney 1854:314). However, the mine was extensively redeveloped by E.L. Smith from 1907 to 1913 (Abbott *GMC* 1964:306; EMJ 1908:48, 1909:112; McCaskey 1909:568). In 1944 the workings were reported to consist of a small inclined stope, 70 ft deep, connected to the surface by a 50 ft adit, with an irregular opening in the back of the stope. At the north end close to the ore outcrop was a 40 ft drift and a flooded winze sunk about 40 feet down the dip of the vein below the stope north of the adit (White and Eric 1944:27). The majority of the features on the surface likely date from the 1907–1913 period of activity, which generated a considerable amount of waste rock, waste ore, and associated ground disturbance. It is unclear what, if any features survive from Barbour and Allen's brief, limited mid-nineteenth-century mining episode.

The Smith Mine Subsite was subjected to subsurface testing in the form of seven test pits (JTPs 23–27) (Figure 7-67). The test pits were placed around visible foundation remains, well, and waste rock piles. The testing in the east part of the subsite, closest to Road 17 and the well, revealed the presence of waste rock and mottled fill deposits from just under the duff (5 to 10 cmbs) to the limit of hand excavation at 45–50 cmbs, where test pits bottomed out on bedrock and the water (Figure 7-65b). The testing around Foundation 10 indicated the presence of waste rock to 11 cmbs, overlying what appeared to be a buried (redeveloping?) A horizon (10 YR 3/2 very dark gray-brown silty sand). Natural B subsoils (10 YR 3/6 dark yellow-brown silty sand, 7.5 YR 4/3 brown silty sand) were encountered below the buried A to the limit of hand excavation at 65 cmbs (Figure 7-65c). The testing around Foundation 11 (reservoir) revealed the presence of dark brown silty sand (overburden?) from just under the duff to 18 cmbs where the test pit terminated on bedrock (Figure 7-65d). The testing within the development rock pile near the visible mine shaft revealed the presence of waste rock and cobbles to the limit of hand excavations at 50 cmbs on bedrock (Figure 7-65e).

The archaeological testing recovered a total of 13 cultural materials from 0 to 10 cmbs in the waste rock and rock fill deposits (Figure 7-1 and Appendix A). These materials consist of one piece of flat glass, one iron pipe fragment, one piece of flat metal, eight brick fragments, and two pieces of mortar (Table 7-1). These materials were collected around Foundation 10 and the earthen berm near the mine shaft. These materials are not particularly diagnostic, but appear to be associated with the 1903–1913 mining activity.

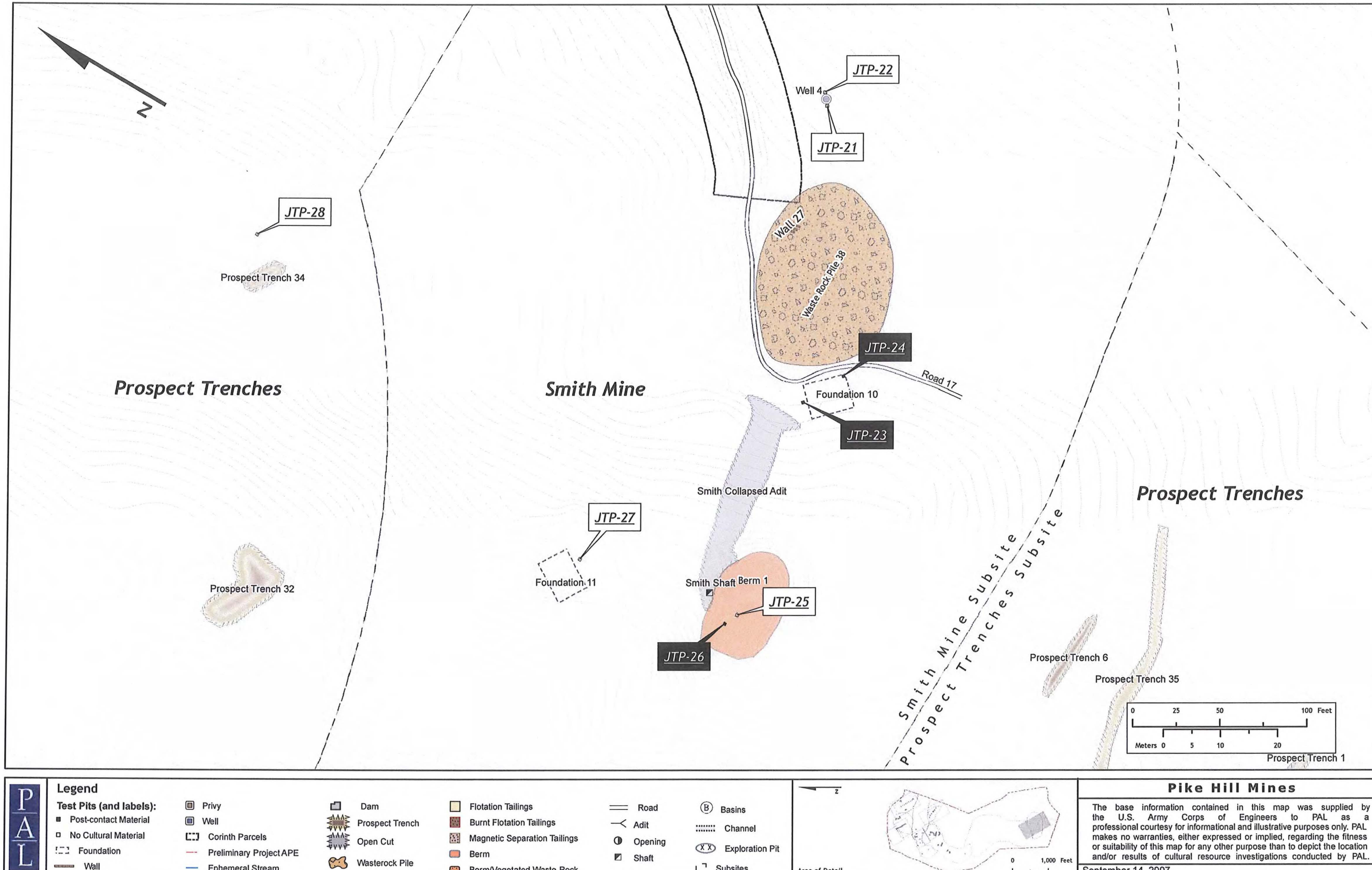

Figure 7-67. Detail plan of Smith Mine Subsite.

Table 7-1. Count of Cultural Materials Recovered from the Smith Mine Subsite.

Material	Count
Brick	8
Glass	1
Iron	2
Mortar	2
Total:	**13**

Isolates

The six industrial isolate sites are located in an approximately 1,500 foot long arc northwest of the Union Mine and New Row subsites. With the exception of the Exploration Adit/Prospect Pits/Waste Rock Pile 39 isolate area, they are all connected by Road 1, which extends north from Road 2 near the center of the Union Mine Subsite, 500 feet southwest of the New Row Subsite dormitory foundation.

Exploration Adit/Prospect Pits/Waste Rock Pile 39 Area

The Exploration Adit/Prospect Pits/Waste Rock Pile 39 Area is located on steep hillside terrain north of the Union Mine Subsite, north of Road 3 and west of Road 1. The exploration adit is a southeast-facing horizontal excavation in the schist bedrock consisting of a short tunnel approximately 5 feet high and of unknown, although probably short length (Figure 7-68). An approximately 50 foot diameter, conical Waste Rock Pile from the excavation of the adit is located immediately southeast of the adit mouth. Two smaller, shallower excavations in the earth, Prospect Pit 1 and Prospect Pit 2, are located east and southeast of the adit mouth, respectively. Prospect Trench 7, a shallow, linear, approximately 125 foot long earth trench similar to the ones in the Prospect Trenches Subsite, is located approximately 100 feet to the southeast.

No historical records associated with these exploration features were located during archival research. The features in this area appear to be associated with ore prospecting and exploration activities at some point between ca. 1845 and the late nineteenth century. The effort required to dig the exploration adit, the volume of resulting waste rock, and the adjacent exploration pits indicate that the bedrock at this location contained promising showings of ore.

Granite Quarry/Cutting Area

The Granite Quarry/Cutting Area is located east of Road 1,250 feet north of the Union Mine Subsite, 450 feet southwest of the New Row Subsite dormitory foundation. It consists of two work areas, the actual quarry pit to the north, and the scatter area to the south. The quarry pit is a roughly 40 foot diameter, 6 ft deep granite bedrock excavation with steep ledge walls on the west and north sides (Figure 7-69). The Scatter Area is approximately 30 feet south and consists of an approximately 60 foot diameter scatter of large granite blocks in varying stages of being cut and trimmed into rectangular blocks.

No historical records associated with these quarry features were located during archival research. The quarry is located in an area of harder, more competent granitic rock within the larger schist formation that the Pike Hill orebodies are emplaced in. The quarry may have served as a source of harder stone that

Figure 7-68. Current photograph showing Exploration Adit, view looking northwest.

Figure 7-69. Current photograph showing Granite Quarry, view looking north.

could be more precisely cut for appropriate applications such as building steps, doorsills, and machinery bases.

Foundation 24

Foundation 24 is located 400 feet north of the Granite Quarry/Scatter Area, and 375 feet northwest of the New Row Subsite dormitory foundation (Figure 7-70). It is a 25 foot by 15 foot fieldstone foundation that straddles an ephemeral stream at the foot of a steep area on the east flank of Pike Hill. The northeast wall of the foundation forms a dam across the stream, which still holds some water behind it.

No historical records associated with Foundation 24 were located during archival research. Foundation 24 appears to have been a dam or cistern for collecting water, possibly for domestic purposes associated with the New Row Subsite dormitory, or for industrial purposes including boiler water for raising steam, or for ore washing or processing.

Wall 6 and Wall 26

Wall 6 and Wall 26 are located at the northernmost extent of the preliminary APE, north of the New Row domestic subsite. Wall 6 is located 180 feet northeast of Foundation 24, and 280 feet northwest end of the northwest end of the New Row Subsite dormitory foundation (Figure 7-71). It is a low fieldstone wall consisting of schist, granite, and quartz boulders. The wall is 140 feet long, with its long axis oriented east-southeast, nearly parallel to the ephemeral stream immediately to the north. Wall 26 is located 180 feet east-southeast, on the same axis as Wall 6, 80 feet north of the possible unfinished dormitory foundation within the New Row Subsite. It is a fieldstone wall of similar construction, also 180 feet long, with a short section that curves to the south at its east end.

No historical records associated with these walls were located during archival research. They do not appear to correspond with any current mapped legal property boundary. They may be associated with non-mining/mining property boundaries or division of livestock grazing fields.

Exploration Pits 5, 6 and 7

Exploration pits 5, 6, and 7 are located between Wall 6 to the northwest and the New Row Subsite dormitory foundation to the southeast. The three pits are spread out over a distance of approximately 80 feet. The pits are a linear series of approximately 10 foot wide overlapping rectilinear bedrock excavations and trenches in rusty sulfidic schist. The excavated rock is piled in small heaps and rows around the pits (Figure 7-72).

No historical records associated with these pits were located during archival research. The type of rock associated with these pits appears consistent with the rock in other exploratory and prospect excavations such as the Exploration Adit and Prospect Pits 1 and 2 isolate area 700 feet to the southwest. The location of these pits, however, is well east of the strike of the orebody exposures and exploratory sites, and these features may be associated with quarrying foundation stones for the nearby New Row dormitory, which has a foundation containing many sulfidic schist blocks.

Figure 7-70. Current photograph of Foundation 24, view looking southeast.

Figure 7-71. Current photograph of Wall 6, view looking northwest.

Figure 7-72. Current view of Exploration Pit 5, view looking northwest.

CHAPTER EIGHT

DOMESTIC RESOURCES – RESULTS AND INTERPRETATIONS

Domestic resources at the Pike Hill Mines Site include the structural remains and associated artifact assemblages of primarily habitation sites. There are no standing structures related to domestic resources within or adjacent to the preliminary project APE. Documentary information pertaining to the historic Pike Hill Mines village is limited to a few late-nineteenth-century photographs and brief descriptions of the village/mine worker housing in historical sources (see Chapter 5 discussion). There are no available historical maps or village maps that detail the Pike Hill Mines domestic structures. From the historical photographs and written sources, it is known that there were three geographically distinct housing areas associated with the mine property at Pike Hill. These include Lower Row, at the foot of the hill closest to the west side of Richardson Road; the Upper Row, located on the hillside upslope (west) of the Lower Row; and the New (or dormitory) Row, situated to the northwest of the Lower Row. A general store was also located to the east (in front) of the Lower Row, closest to Richardson Road. It is unclear where the mine village schoolhouse was located since it is not readily discernable in historical photographs or on the 1858 and 1877 town atlas maps. Since historical accounts of the Pike Hill Mines village are scant in the documentary record, it is also difficult to estimate the number and types of buildings that comprised the Pike Hill Mines worker village at any given time. It is known that there were single-family and two-family duplexes as well as the dormitory, a general store, a schoolhouse, and several barns and outbuildings. All of the documented structures lie within the current 173-acre preliminary APE.

For the purposes of this report, the Pike Hill domestic resource areas are divided into the three domestic subsites (Lower Row, Upper Row, New Row) (see Figure 2-4). Each visible feature, such as a foundation, privy, well, or wall, identified during the fieldwork/mapping component of the project was assigned a survey number. The numbers assigned to foundations were then, where possible, cross-referenced with the historical photographs of the village portion of the site (see Figures 5-3 thru 5-6). The foundations are discussed by number and the text frequently refers to the ca. 1880 and early-twentieth-century historical images to more fully describe and interpret the village remains. This chapter also includes a discussion of the administrative (office building) remains for the Union and Eureka mines. These building foundations are located at the center of industrial activity, but because of their function, are more closely related to the domestic resources in terms of archaeological content.

The visible domestic foundations generally consist of stone-lined cellar holes constructed of dry-laid locally available schist laid in an irregular pattern. Despite the apparent availability of granite, with an outcrop less than 500 ft (152.4 m) uphill from the New Row, schist was the predominant building stone of choice. Schist, much of which was likely quarried from local outcrops or from the mines themselves, is beneficial for structural stonework because it tends to split into tabular slabs. In a few cases, other forms of stone or masonry are employed in construction and these foundations are described in more detail below. A substantial number of the foundations have earthen berms associated with the cellar holes. In many cases the berms are part of the cut-and-fill construction used to level the foundations on the steep hillside. In other cases the berms represent extensions to the foundation and appear to have supported a portion of the building. The foundations are arranged in rough lines along historical mine roadways, many of which are still evident and were also given a survey number.

Lower Row

The Lower Row lies in the eastern corner of the project APE. It is depicted in the ca. 1880 photographs of the site, which show nine one-story wood-frame dwellings, each with a center chimney. The houses extended along a linear terrace that overlooked the stream drainage and Richardson Road to the northeast (see Figures 5-3 and 5-5). The current survey identified this subsite as encompassing 10 visible foundations within a 6-acre area along a wooded, secondary growth terrace landform (see Figure 2-4; Figure 8-1). Nine of the foundations are arranged in the linear northwest-southeast alignment, extending 440 ft (134 m) along the terrace at the same elevation contour of approximately 1,540 ft amsl. Earthen berms are built up on the downslope (southeast) side of the foundations to compensate for the natural gradient, which ranges from 3 to 50 percent in this area. Most if not all of the foundations are positioned on bedrock ledge outcrops, which seem to have impeded the size, shape, and depth of cellar hole components. The cellar holes appear to have been uniformly shallow, probably just sufficient in size and shape for a crawl space and cold storage use.

Three privies, one well, and one stone wall were identified in proximity to the house foundations (see Figure 8-1). No visible structural remains of the general store, depicted near the Lower Row structures in the historical photographs, were identified during the survey. The general store was a one- and one-half-story wood-frame structure with a covered porch along its east elevation. The documented location of the store is currently obscured by dirt and gravel fill placed for informal vehicular parking closest to the Road 2 entrance off Richardson Road. The subsite is accessed off Richardson Road by Road 2, which runs west up the hill to the industrial mine working areas. Foundations 1, 2, and 13 are located to either side of the mine road as its winds uphill.

Foundation 1 is located 220 ft (67 m) uphill from Richardson Road and is the only foundation in the row on the north side of Road 2. It appears in one of the ca. 1880 photographs as a one-story wood-frame building with center door and chimney (see Figure 5-4). It appears to be slightly larger than the houses in the row to the southeast on the opposite side of the road, which may indicate its use as a supervisor's house. The foundation remains include an L-shaped cellar hole, supported on the north-northeast side by an earthen berm that blends into the downslope of the terrace. The entire foundation measures 15-x-30 ft (4.5-x-9.1 m), with depths from 5 ft (1.5 m) below surface in the center to grade on a raised 8-x-10 ft (2.4-x-3.1 m) berm in the northwest corner. There are visible dry-laid courses of schist stonework in the foundation walls, although the number of intact courses could not be determined because of dense overgrowth and slope wash.

Well 1 is situated approximately 130 ft (39.6 m) uphill and northwest of Foundation 1. A small pump house or similar structure appears at/near this location in one of the ca. 1880 photographs (see Figure 5-4). The well is constructed of rough dry-laid fieldstone and is somewhat oval in shape (probably because of slumpage), measuring 6 ft (1.8 m) across at its widest and 3 ft (0.9 m) across at its narrowest (Figure 8-2). It contained standing water at the time of the survey.

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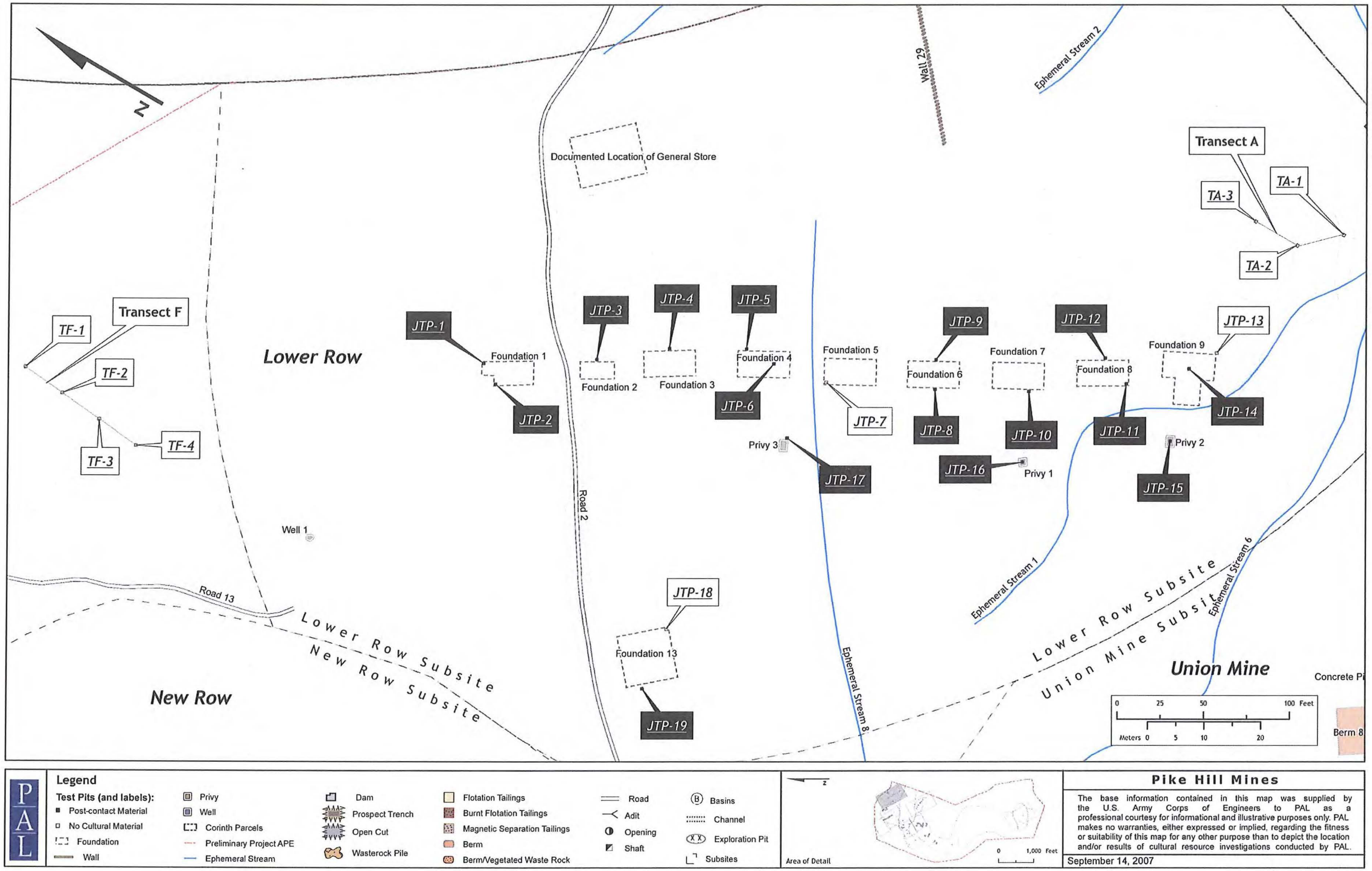

Figure 8-1. Detail plan of the Lower Row Subsite.

Figure 8-2. Current photograph of Well 1, view looking north.

Foundation 2 is located 27 ft (8.2 m) south-southeast of Foundation 1 just south of Road 2. The structure at this location appears slightly set back from the rest of the Lower Row in the historical photographs (see Figure 5-3 and 5-5). The photographs also depict a small wood-frame (privy?) structure to the immediate southwest (left in the photograph) of Foundation 2. No evidence of this privy was identified in the field. The house foundation consists of a considerable berm that wraps around the east and south sides. The berm is the most substantial one observed in the Lower Row house foundations. Its cellar is either filled in or nonexistent. Instead, there is a nearly level, flat and compact ground surface, which measures 10-x-20 ft (3.1-x-6.1 m), and most likely represents the interior "floor" surface of the structure. The wooden floor boards may have been laid very close to this flattened, compact ground surface. The flat area is structurally supported by the berm, with very few surface stones noted on the ground.

Foundation 3 is located 17 ft (5.2 m) south-southeast of Foundation 2, continuing along the same contour of the terrace. It consists of one cellar hole, measuring 15-x-30 ft (4.5-x-9.1 m). The down slope side of the foundation is supported by an earthen berm that blends into the terrace slope. The vegetation and overburden surrounding this foundation is substantial, ranging from saplings to larger, more mature trees that are 1 ft (0.3 m) or more in diameter. No courses of the original foundation stonework are visible. The depth of the cellar is slight and ranges from 2 ft (0.6 m) in the center to less than 1 ft (0.3 m) along the walls, because of slope wash and overburden.

Foundation 4 is located 25 ft (7.6 m) south-southeast of Foundation 3 and 14 ft (4.3 m) north-northeast of Ephemeral Stream 8. It consists of one cellar hole, measuring 15-x-30 ft. The cellar retains water quite well, suggesting that it was perhaps built directly on ledge. While similar foundations in the area retain little or no water, Foundation 4 contained about 1 ft (0.3 m) of standing water at the time of the fieldwork. Dense vegetation and slope wash have obscured any extant stonework that may be present. Like other foundations in the row, it has fairly thick vegetation throughout, with two larger trees, about 1 ft (0.3 m) in diameter each, growing in the northeast corner.

Privy 3 is located southwest of Foundation 4, approximately 35 ft (10.7 m) uphill. It is not readily discernable in the historical photographs that depict the Lower Row. Privy 3 is constructed of 12 visible courses of dry-laid fieldstones, five of which were underwater at the time of the survey (Figure 8-3). It is rectangular in shape, measuring 4-x-6 ft (1.2-x-1.8 m). The full depth of the privy could not be determined. Two feet of standing water were present inside the privy, and the water line was 4 ft (1.2 m) below the uppermost course of stones. The privy is supported to the northeast by a berm and has very little surrounding overburden or vegetation.

Foundation 5 is located 20 ft (6.1 m) south-southeast of Foundation 4 and 6 ft (1.8 m) south-southeast of Ephemeral Stream 8. The foundation consists of a 15-x-30 ft (4.5-x-9.1 m) area with a very shallow and faintly discernable cellar hole surrounded by earthen berms on the down slope side. There is no visible stonework associated with the cellar hole and earthen berms, possibly because the area is heavily overgrown and slope wash has obscured any foundation walls. Two trees larger than 1 ft (0.3 m) in diameter are growing in the north end of the cellar hole.

Foundation 6 is located 19 ft (5.8 m) south-southeast of Foundation 5. It contains a 15-x-30-ft (4.5-x-9.1 m) cellar hole, which is 4 ft (1.2 m) in depth at its deepest and less than 1 ft (0.3) at the corners. It is supported by a small berm on the down slope side that blends into the terrace. A triangular portion of ledge measuring 7-x-7-x-10 ft (2.1-x-2.1-x-3.1 m) is exposed in the northwest corner of the foundation. The foundation's east wall has approximately 5 courses of dry-laid schist exposed. It contained standing water at the time of the survey, most likely because of the shallow bedrock.

Figure 8-3. Current photograph of Privy 3, view looking west.

Foundation 7 is located 18 ft (5.4 m) south-southeast of Foundation 6. It contains a 15-x-30-ft (4.5-x-9.1 m) cellar hole, which is supported by a berm on the down slope side. Intact courses of stonework are visible in all four of the foundation's walls. A large tree of about 2 ft (0.6 m) in diameter had been growing on and slowly breaking up the south wall of the foundation. It had recently fallen down across the cellar hole interior. A large granite block, probably a door threshold, is present just to the south of the stump of the fallen tree (Figure 8-4).

Privy 1 is located about 45 ft (13.7 m) to the west-southwest of Foundation 7. It is 4-x-4 ft in dimension, but the foundation remains are limited to the north, east, and south walls. At least two courses of dry-laid schist are present. The privy is located at the bottom of a small slope and slope wash has nearly completely filled it in. This privy is also not discernable in the historical photographs that depict the Lower Row, although it is likely that every house, or at least every other house, had its own privy at one time.

Foundation 8 is located 19 ft (5.8 m) south-southeast of Foundation 7 and, because of its relatively good state of preservation and structural similarity to the other Lower Row foundations, it was chosen for a precision survey with the Leica Total Station (Figure 8-5). The foundation is approximately 15-x-25 ft (4.5-x-7.6 m), with a 15-x-15-ft (4.5-x-4.5-m) cellar hole and a 10-x-15-ft (3.1-x-4.5-m) level, flat and compact ground surface on the northwest side. The cellar hole is approximately 4 ft (1.2 m) deep at its deepest and 2 ft (0.6 m) in the corners. The upper course of stones in the foundation have been robbed out along the flat, level area on the northwest side, making it flush with the surrounding ground surface. The entire foundation contains approximately 8–10 courses of intact, irregular dry-laid schist visible in the interior elevation (Figure 8-6).

Foundation 9 is located 20 ft (6.1 m) south-southeast of Foundation 8 and is irregular in shape. It consists of a 15-x-30-ft (4.5-x-9.1-m) cellar hole with a 15-x-15-ft (4.5-x-4.5-m) ell addition (level, flat and compact ground surface) to the rear (west) side. This foundation is also supported by berms to the east and south, both down slope blending into the terrace. The cellar hole is very shallow, ranging from 2 ft (0.6 m) to grade and bedrock is exposed in the northern end.

Privy 2 is located about 19 ft (6 m) west of Foundation 9. It is roughly rectangular in shape, measuring 4-x-6 ft (1.2-x-1.8 m) and about 1 ft (0.3 m) deep at the center. The privy feature is mostly filled in with slope wash and vegetative overburden, but dry-laid fieldstones are visible on all four sides (Figure 8-7).

Foundation 13 is located adjacent to Road 2, approximately 150 ft (45.7 m) uphill (west) of Foundation 2. It is visible in the historical photographs, and also appears to have been a one-story wood-frame structure similar in size and shape to the other Lower Row dwellings. The foundation remains consist of a flat, level and compact ground surface supported by a berm on the downslope (east) side that blends into the terrace in the hillside. The foundation is constructed of dry-laid slabs of schist, which are flush with the flat, level ground surface. Several large granite/quartz blocks are incorporated into the eastern foundation wall.

Twenty-two test pits were excavated within the Lower Row Subsite. Nineteen of these test pits (JTPs 1–19) were placed within and adjacent to Foundations 1–9 and 13. In general, the soil profiles of these test pits confirm that the terrace on which the foundations were constructed had been landscaped and built up artificially on the downslope (or east) sides to support the structures using cellar hole ejecta for fill. The soil profiles around the perimeters of the foundations where there is no fill present consist of a layer of

Figure 8-4. Current photograph of Foundation 7, showing possible door threshold stone, view looking north.

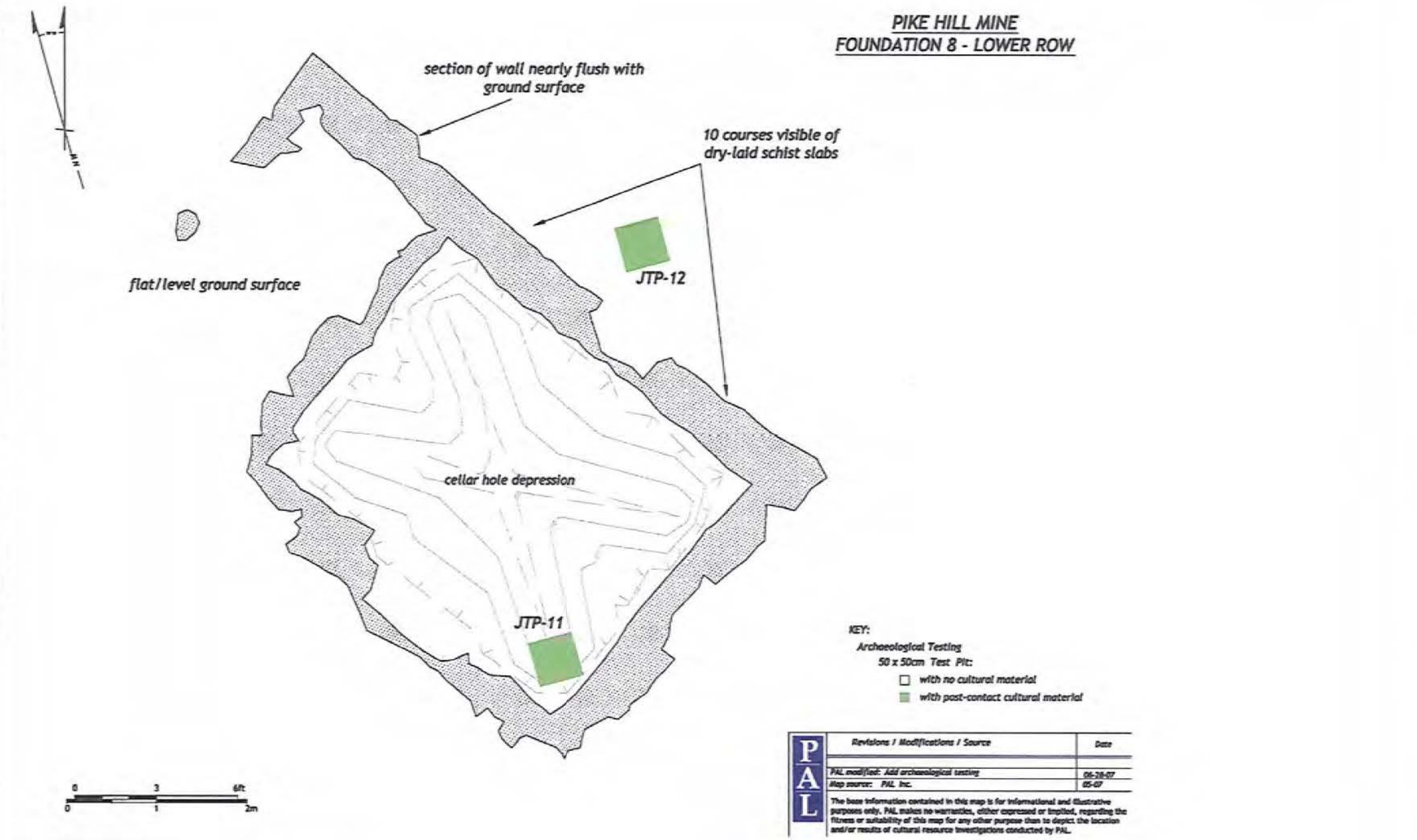

Figure 8-5. Detail plan of Foundation 8.

Figure 8-6. Current photograph of Foundation 8, view looking southeast.

Figure 8-7. Current photograph of Privy 2, view looking east.

duff overlying an A horizon dark brown sandy silt (10 YR 2/2) to 25 cmbs, followed by a B_1 horizon of yellow-brown (10 YR 3/4) silty sand (Figure 8-8a). In most cases, bedrock ledge was encountered in the B horizon soils. Bermed areas around the foundations generally contained between 20 and 50 cm of dark brown sandy (10 YR 2/2) and mottled dark yellow-brown (10 YR 4/4) and dark brown (7.5 YR) sandy A/B horizons, overlying either bedrock ledge or a buried A horizon (Figures 8-8b, 8-8c). Test pits excavated within the foundation/cellar holes contained multiple layers of fill/overburden consisting of dark gray-brown silty sand most of which were very wet and some with standing water, directly on bedrock ledge (Figure 8-8d). The ledge appears to have served as the floor surfaces of the shallow cellar holes. The testing resulted in the recovery of 323 cultural materials on the ground surface, in A topsoils and in cellar hole ejecta/fill deposits from 0 to 60 centimeters below surface (cmbs) (Table 8-1 and Appendix A). The majority of the materials consist of plain window (n=104) and molded (n=49) bottle

Table 8-1. Count of Cultural Materials Recovered from the Lower Row Subsite.

Material	Count
Bone	12
Brass	1
Brick	12
Metal	6
Glass	104
Glass Molded	49
Iron	76
Ironstone	31
Kaolin	3
Lead/Pewter	2
Leather	1
Mortar	5
Paper	1
Plastic	1
Porcelain	8
Redware	1
Stoneware	5
Whiteware	4
Wood	1
Total:	**323**

and chimney glass. Iron items (machine cut and wire nails, a mule shoe, 3-tine forks, door hardware) are the next most prevalent material type (n=76) followed by much lesser amounts of ceramic sherds (redware, whiteware, stoneware, ironstone, and porcelain), butchered animal bone, brick, and wood. The recovered artifact assemblage including household items and construction materials is consistent with the documented mid- to late-nineteenth-century domestic occupation of the Lower Row.

Additional testing in the Lower Row Subsite was conducted along Transect A, containing three test pits, placed about 80 ft (24.4 m) to the southeast of Foundation 9. This testing was used to investigate an intact terrace overlooking a series of nearby ephemeral streams related to the Pike Hill Brook drainage for potential evidence of pre-contact period activity. These test pits contained a dark brown fine silty sand A horizon to an average depth of 25 cmbs, underlain by dark yellow brown B horizon sandy silt to the limit of excavation at 75-80 cmbs (Figure 8-8e). No cultural materials were recovered in any of these test pits.

Upper Row

The Upper Row is the southwestern-most mine-related domestic subsite within the APE. It is depicted in the ca. 1880 photographs of the site, which show six one-story wood-frame duplex dwellings, each with a double center chimney. The houses extended along a linear terrace southwest of the mine workings area about midway up the hillside (see Figures 5-3 and 5-5). The current survey identified this subsite as encompassing six visible foundations within an approximate 2-acre area along a wooded, secondary growth terrace landform (see Figure 2-4). All six foundations are arranged in the same linear northwest-southeast alignment as the Lower Row. They extend a distance of 360 ft (109.7 m) on the same elevation contour at approximately 1,660 ft above sea level (Figure 8-9). Earthen berms are present on the downslope (east) side of many of the foundations to compensate for the natural gradient, which ranges from 3 to 35 percent in this area. Similar to the Lower Row foundations, bedrock ledge outcrops appear to have served as Upper Row house foundations with irregularly shaped cellar holes resulting from the shallow ledge deposits. Other identified features in the Upper Row Subsite include one well, one privy, and a domestic trash dump. The house foundations are accessed from Copper Mine Road via a system of private one-lane dirt roads from the southwest. Unnamed roads that run through the Upper Row include Roads 6, 8, and 9, the latter two being roads that pass solely around the house foundations to the east and south sides.

Foundation 35 is located less than 400 ft (121.9 m) to the east of the base of the flotation mill. The overall foundation measures 20-x-35 ft (6.1-x-10.7 m) and has a cellar hole that is about 3 ft (0.9 m) deep. These dimensions are basically the same for all six foundations in the Upper Row. The foundation is supported by a large berm on the down slope (east) side. There are roughly four courses of dry-laid schist visible in the north foundation wall, but the remaining walls are obscured by dense vegetation and overburden or slope wash. Several larger cut stones are slightly visible in the foundation's east wall.

Privy 5 is located adjacent to Foundation 35 and is oriented at an angle of 55º off the foundation's western wall. The privy consists of a squarish depression measuring 5-x-7 ft (1.5-x-2.1 m) and about 2 ft (0.6 m) deep. No extant courses of stonework that may have lined the privy pit are visible. This privy is visible in the ca. 1880 photographs that depict the Upper Row duplexes (see Figures 5-3 and 5-5).

Foundation 37 is located 20 ft (6.1 m) southeast of Foundation 35. It contains a 20-x-35-ft (6.1-x-10.7 m) cellar hole that is supported by a berm on the downslope (southeast) side. The cellar hole is 2 ft (0.6 m) deep, and there are visible cut granite blocks in the east wall. Vegetative overburden and slope wash obscure additional stonework that is likely present in the foundation walls. There is a visible 4-ft (1.2 m) opening in the center of the east wall, which could represent an entrance to the cellar area. No steps are visible in this area.

Foundation 38 is located 20 ft (6.1 m) southeast of Foundation 37. It contains a 20-x-35-ft (6.1-x-10.7 m) cellar hole, also supported by a berm on the downslope (southeast) side. The cellar hole is 3 ft (0.9 m) deep, although dense vegetation, including numerous saplings and three large trees measuring at least 1 ft in diameter each, obscure the actual shape and depth of the cellar hole. Three large cut granite blocks are visible in the east and north foundation walls, but any additional stonework that may be present is obscured by the dense vegetation.

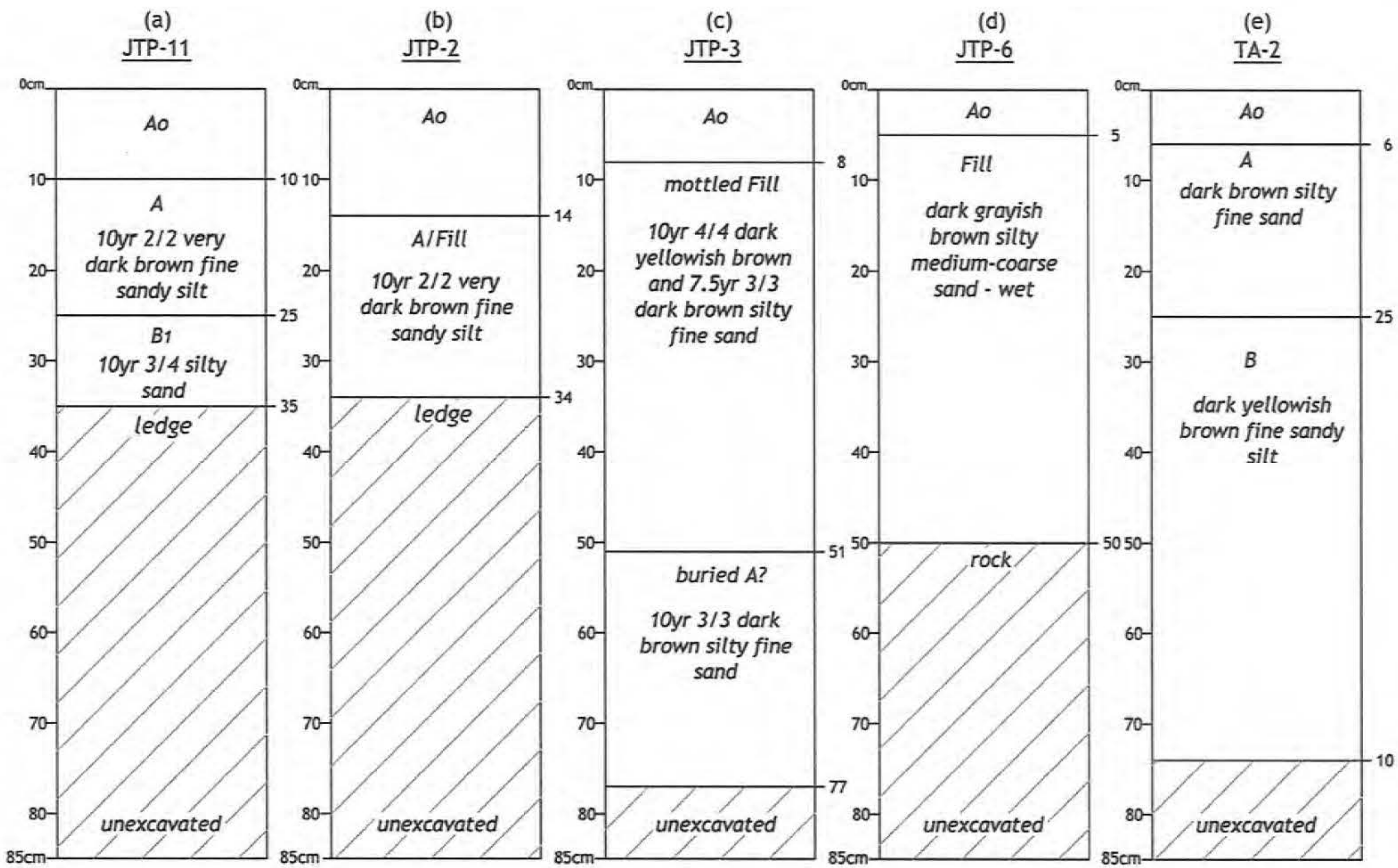

Figure 8-8. Representative test pit profiles in the Lower Row Subsite.

Foundation 39 is located 35 ft (10.7 m) southeast of Foundation 38. The remains contain a 20-x-35-ft (6.1-x-10.7 m) cellar hole with a 5-x-5-ft (1.5-x-1.5 m) ell addition on the north end. The foundation is supported by a large berm on the downslope (southeast) side. The cellar hole is only about 1 ft (0.3 m) deep and appears to have been mostly filled with slopewash and overburden.

Foundation 40 is located 15 ft (4.3 m) southeast of Foundation 39. It is most representative of the Upper Row foundation remains and was therefore selected for a precision survey with the Leica Total Station (Figure 8-10). The foundation consists of a 25-x-35-ft (7.6-x-10.7 m) cellar hole, which measures nearly 5 ft (1.5 m) deep in parts and is supported by a large earthen berm on the downslope (southeast) side (Figure 8-11). An opening in the north foundation wall is clearly discernable; it may be an entrance to the cellar although no steps are visible. An outcrop of ledge, measuring approximately 25 ft (7.6 m) around, is present in the southwest corner of the foundation. A large pile of disarticulated bricks is present in the east-central portion of the cellar hole, probably representing one or both of the dual central chimneys as shown in the ca. 1880 photographs of the Upper Row houses. The visible portions of the foundation walls, particularly on the eastern interior face, are comprised of mortared schist slabs, eight courses of which are visible through the vegetation and overburden.

Foundation 41 is located 30 ft (9.1 m) southeast of Foundation 40. It contains a 20-x-35-ft (6.1-x-10.7 m) cellar hole, which is also supported by a berm on the downslope (southeast) side. Timbers and cast-iron pipes are visible on the ground surface along the east foundation wall (Figure 8-12). The southwest corner of the foundation contains four courses of visible dry-laid schist slabs. The cellar hole depression is 3 ft (0.9 m) at its deepest and has a large build up of overburden in the center, which is nearly flush with the foundation walls to the east and west. This large pile of overburden contains mid-twentieth-century debris including mattress springs, car parts, brick, wood, and butchered animal bone that appear to have been dumped here from the truck access of Road 9.

Well 2 is located 40 ft (12.2 m) southwest of Foundation 41, on the opposite (southwest) side of Road 9. The well is roughly circular and measures 5 ft (1.5 m) in diameter. It retains water and has approximately eight dry-laid courses of intact fieldstones (Figure 8-13).

Twenty-four test pits were excavated within the Upper Row Subsite. All of these test pits (JTPs 37–60) were placed within and adjacent to Foundations 35, 37 thru 41 and the identified well and privy. In general, the soil profiles of these test pits confirm that the terrace on which the foundations were constructed had been landscaped and built up artificially on the downslope (or east) sides to support the structures using cellar hole ejecta for fill. No natural soil horizons were encountered in any of the test pits; they ended up all being placed in areas of multiple fill related to the construction/occupation and abandonment of the house foundations. The soil profiles around the perimeters of the foundations generally consist of a layer of duff overlying a dark brown (10 YR 2/2) silty sand intermittently mottled with dark yellow-brown (10 YR 4/6) silty sand that averaged 70 cmbs, and in most cases extended beyond the limit of hand excavation at 120 cmbs (Figures 8-14a, 8-14b). Test pits excavated within the foundation/cellar holes contained multiple layers of fill/overburden consisting of brown (10 YR 4/3), dark gray (10 YR 4/1 and 4/2), and dark olive-brown (2.5 Y 3/3) sands to the limit of excavation at 90 cmbs (Figure 8-14c, 8-14d). The ledge appears to have served as the floor surfaces of several if not all of the cellar holes.

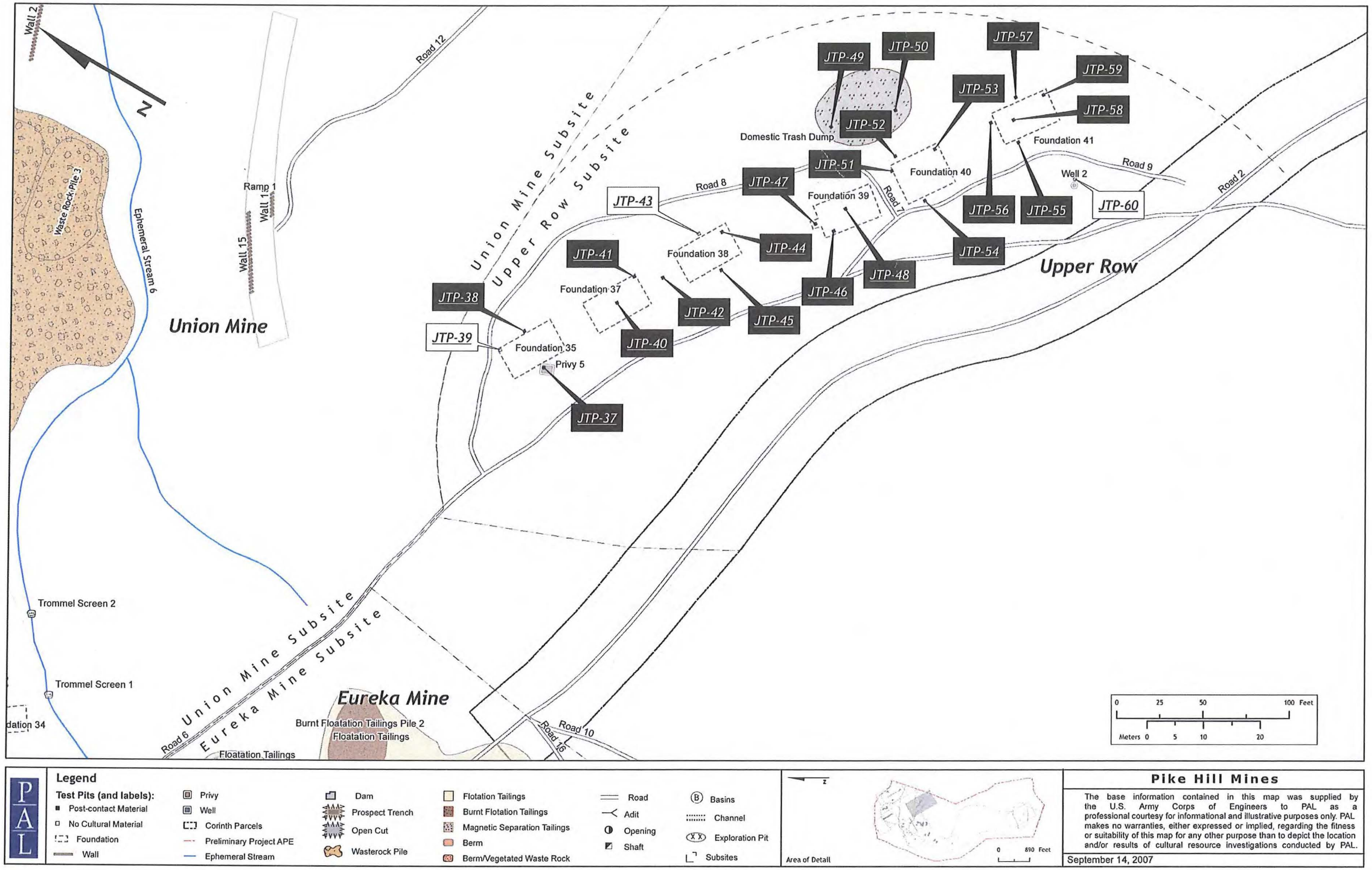

Figure 8-9. Detail plan of the Upper Row Subsite.

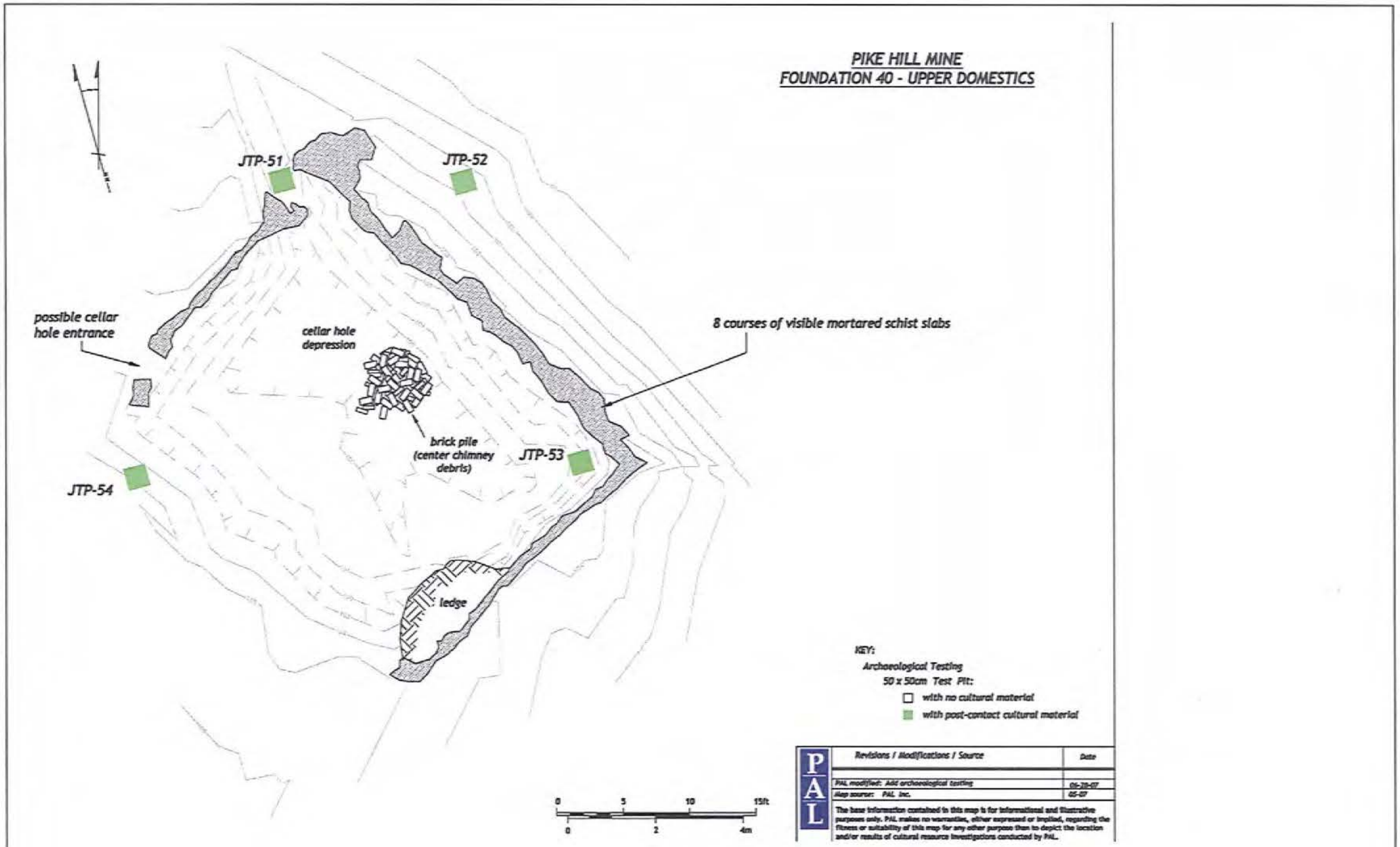

Figure 8-10. Detail plan of Foundation 40.

Figure 8-11. Current photograph of Foundation 40, view looking southeast.

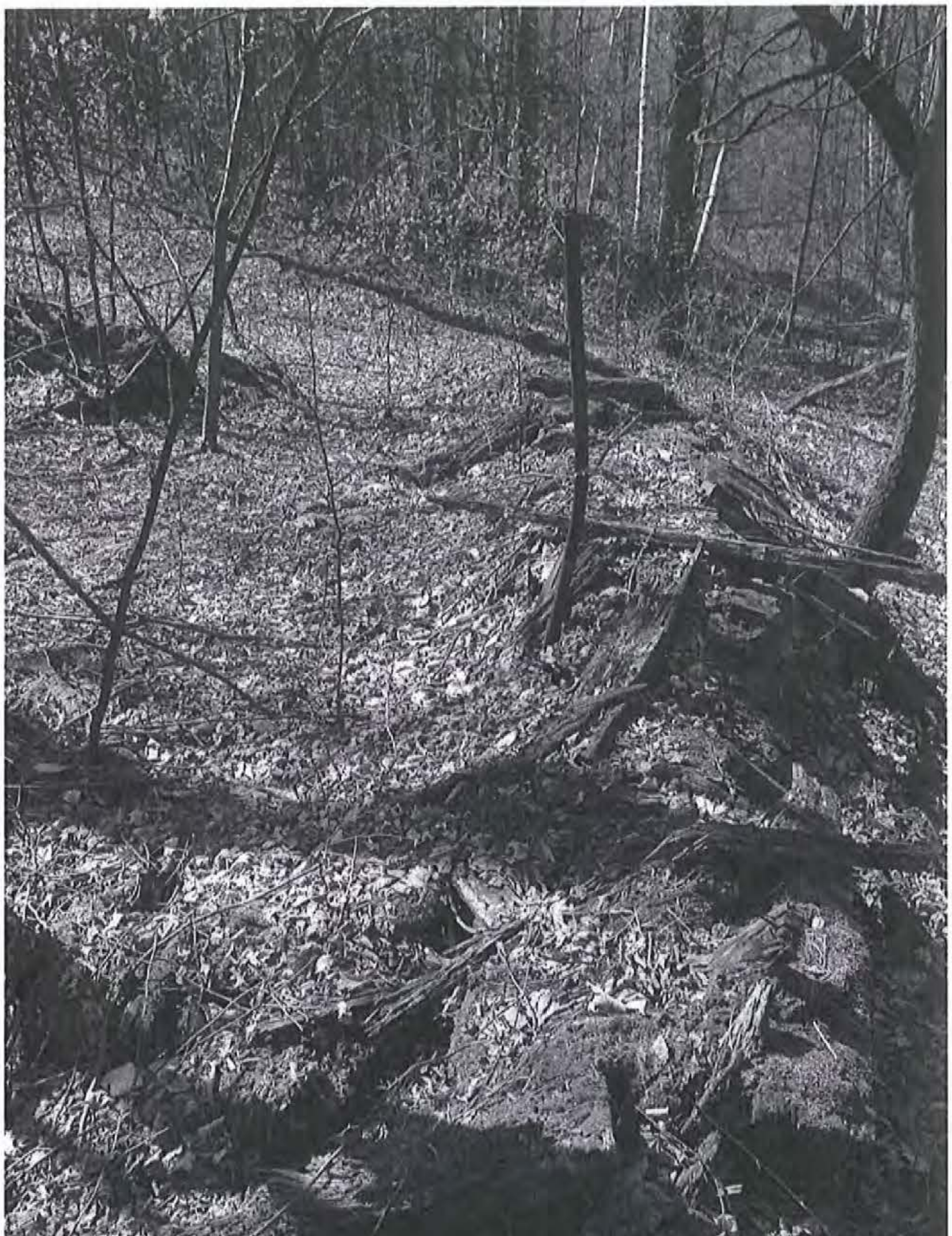

Figure 8-12. Current photograph of Foundation 41, showing wood timbers and cast-iron pipes along east foundation wall, view looking north.

Figure 8-13. Current photograph of Well 2, view looking southwest.

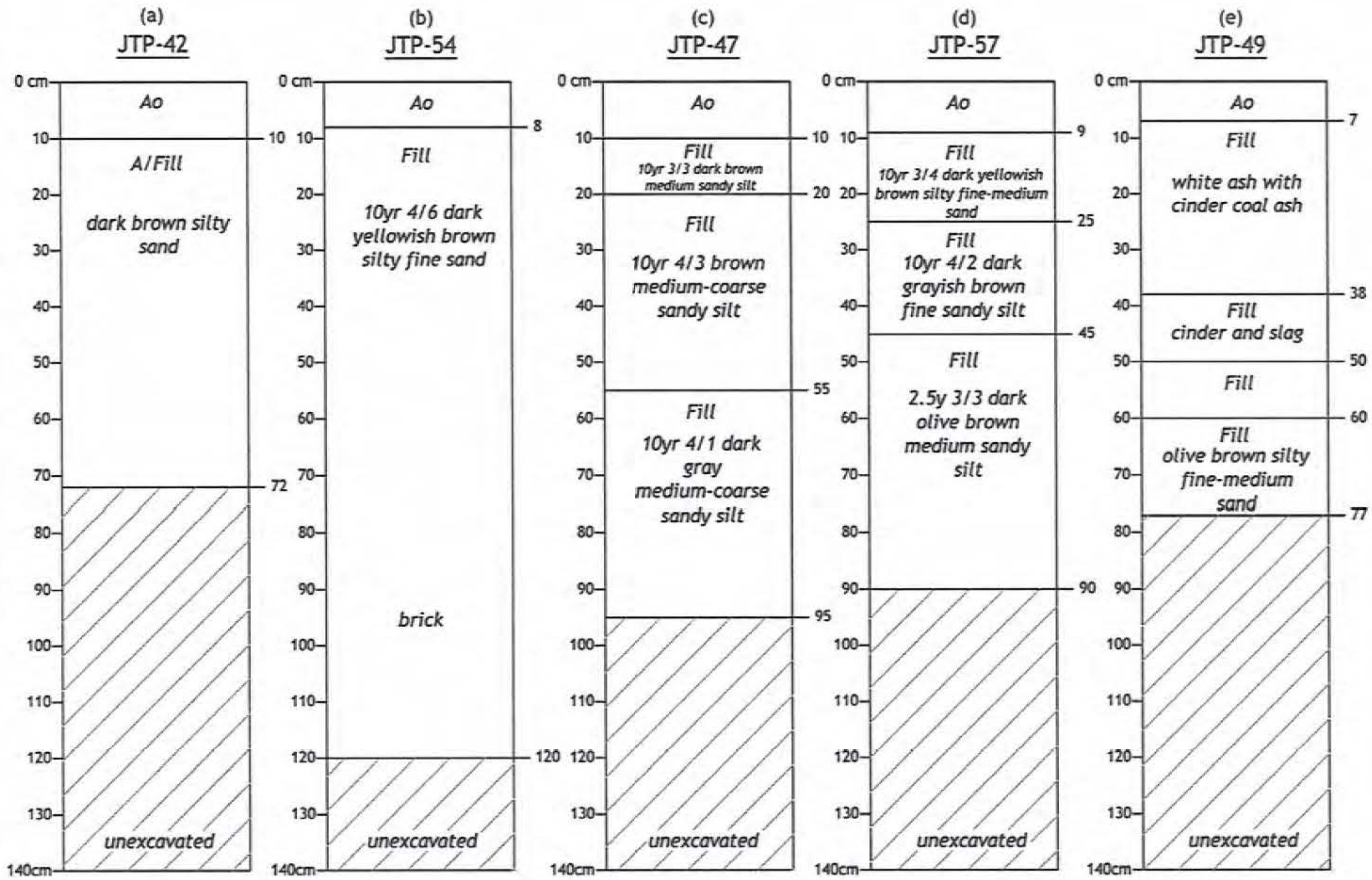

Figure 8-14. Representative test pit profiles in the Upper Row Subsite.

The testing resulted in the recovery of 1,183 cultural materials in the various fill deposits encountered in and around the cellar holes and in discrete trash dumps from 0 to 80 cmbs (Table 8-2 and Appendix A). The recovered cultural materials in the Upper Row are very similar in type and function to those recovered in the Lower Row. Construction materials dominate this artifact assemblage, with plain window glass (n=343) and iron items (machine cut and wire nails, door hardware) (n=382) being the most prevalent of these items. Extensive mortar and brick debris was encountered throughout many of the test pits, most likely resulting from chimney falls and demolition/salvage debris. Like in the Lower Row, ceramic sherds from tablewares (plates, bowls) were also encountered in the Upper Row in much lesser densities (n=124). Ceramic types are also similar and include redware, whiteware, yellow ware, stoneware, ironstone, and porcelain. Butchered animal bone was found in much higher densities (n=126) throughout the site, but was particularly concentrated in JTP 47 placed inside the Foundation 39 cellar hole. Personal items found in/around the house foundations include a brass buckle (molded lettering “PATENT 1866”), porcelain buttons, and kaolin pipe fragments.

A domestic trash dump was identified on the downslope (eastern) side of Foundations 39 and 40. The debris was intermixed with heavy deposits of dark/brown and black greasy soil containing ash, slag/clinker, and coal. The presence of industrial waste products suggests that some of this debris may have come from the mine buildings that post-dated the worker habitations in this area, such as the ore mill and offices to the north and west. Two test pits, JTPs 49 and 50, were placed within the trash dump area. This testing revealed the presence of multiple fill or dumping deposits, each containing ash, cinder, coal

Table 8-2. Count of Cultural Materials Recovered from the Upper Row Subsite.

Material	Count
Ash	2
Bone	126
Brass	3
Brick	52
Ceramic	1
Coal	25
Glass	343
Glass Molded	28
Iron	382
Ironstone	67
Kaolin	2
Lead/Pewter	1
Metal	34
Mortar	22
Paper	4
Porcelain	13
Redware	1
Rubber	1
Slag/Clinker	17
Slate	2
Stoneware	2
Textile	1

Material	Count
Unidentified	1
Whiteware	47
Wood	3
Yellowware	3
Total:	**1183**

ash, and slag from just under the duff layer to at least 77 cmbs at the limit of excavation (Figure 8-14e). Recovered materials in these two test pits include fragments of automobile headlights (McKee Glass Co. dated 1917), wire nails, bottle caps, and ironstone ceramic sherds. JTP 52 was placed in this same area between the dump and Foundation 40. It contained primarily mid-twentieth-century household items including a molded medicine bottle manufactured by "Owens Illinois Glass Co. in Clarksbury WV (1930–1944) and several pages from a KKK national weekly newspaper called the "Fellowship Forum" dated September 1924.

Like with the Lower Row, the majority of the Upper Row artifact assemblage including household items and construction materials is consistent with the documented mid- to late-nineteenth-century domestic occupations. However, there is also artifactual evidence (e.g., bottles, car parts, newspaper print) of early/mid-twentieth-century dumping of household refuse and industrial waste in and around the Upper Row foundations, both during the last mining campaign at the ore mill (1915–1919) and by local residents in the following decades. Various automobile parts dating to the 1940s and 1950s also surround the foundations on the downslope (southeastern) slopes.

Administrative – Offices

The administrative offices for the Union and Eureka mines are located at the center of industrial activity on Pike Hill approximately one-quarter mile west up Road 2 from Richardson Road between 1,680 ft and 1,700 ft amsl (see Figure 2-4). The offices appear on the ca. 1880 and early-twentieth-century photographs (see Figures 5-4, 5-6, 5-8, 5-9, and 5-11). The environs are quite different from those of the domestic subsites. Because of metal concentrations in the soil and the presence of waste rock, there is very little vegetation in the area. Waste rock and tailings piles dominate the immediate landscape.

The Union Office (Foundation 33) is located on Road 6 between Road 1 and Foundation 36 at 1,682 ft amsl. It represents one of the better preserved structural remains in the entire Pike Hill Mines Site, suggesting that it was one of the last standing buildings at the site. It measures 20-x-25 ft (6.1-x-7.6 m) and has a 4-x-4-ft (1.2-x-1.2-m) ell addition at the north end, which served as an entrance to the cellar. An interior wall runs north-south through the center of the foundation/cellar hole. The cellar hole measures approximately 4 ft (1.2 m) in depth throughout and appears to have had a dirt floor. There are between 8 and 10 extant courses of dry-laid stonework visible in all four foundation walls (Figure 8-15). Fallen floorboards and support timbers are also present in/around the foundation walls.

Three test pits (JTPs 34–36) were placed at the Union Office foundation (Figure 8-16). The test pits revealed the presence of demolition layers and fill deposits (including intermixed waste rock) from just under the duff to the limit of hand excavation between 50 and 85 cmbs (Figure 8-17a). The testing recovered a total of 153 cultural materials from 0 to 40 cmbs in the demolition and fill layers (Table 8-3 and Appendix A). The majority of these materials (n=125) consist of plain window glass along with six

Figure 8-15. Current photograph of Foundation 33 (Union Mine Office), view looking northeast.

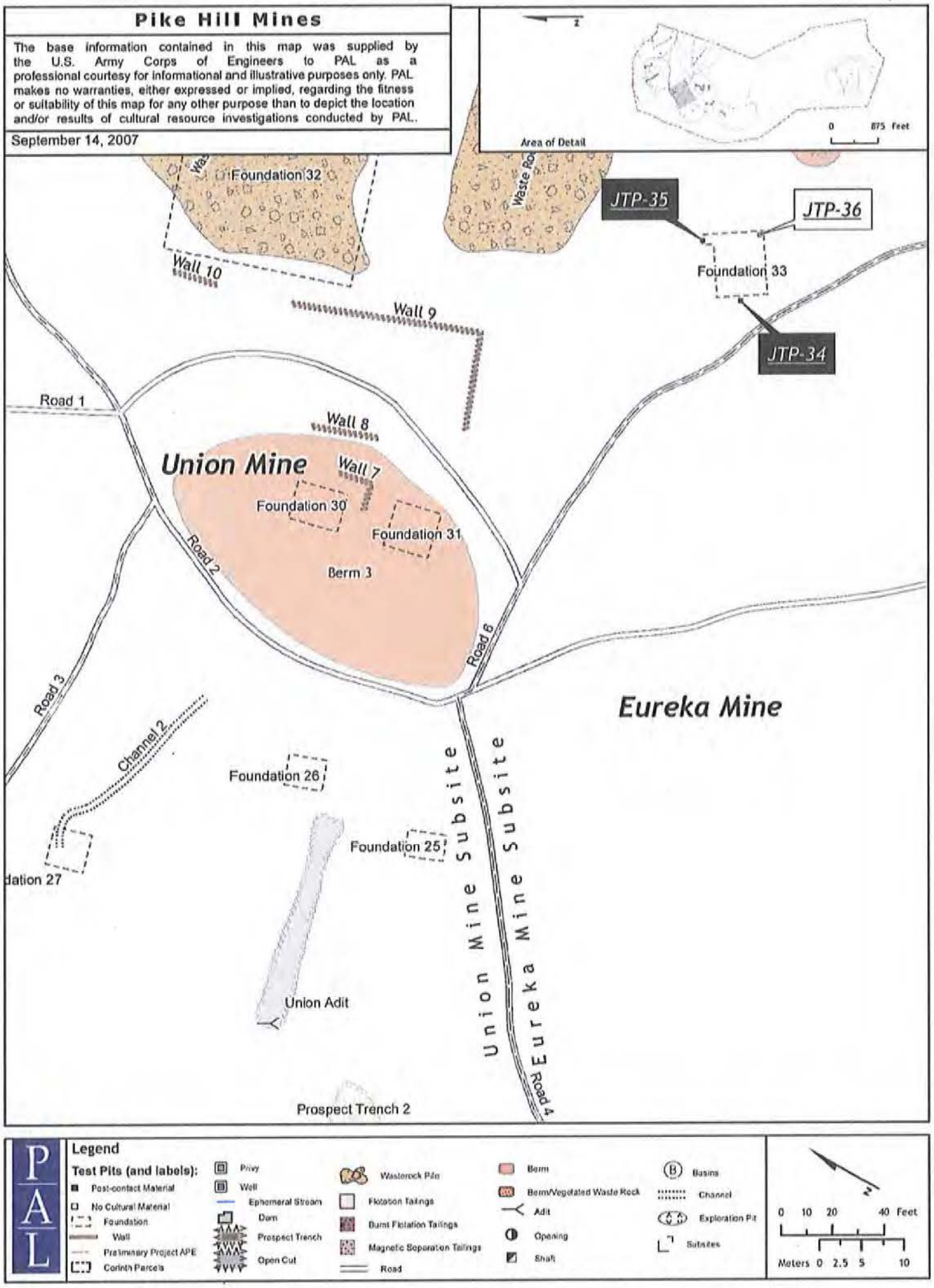

Figure 8-16. Detail plan of Union Mine Office (Foundation 33) testing area.

Pike Hill Mines Historic and Archaeological Survey August 2007

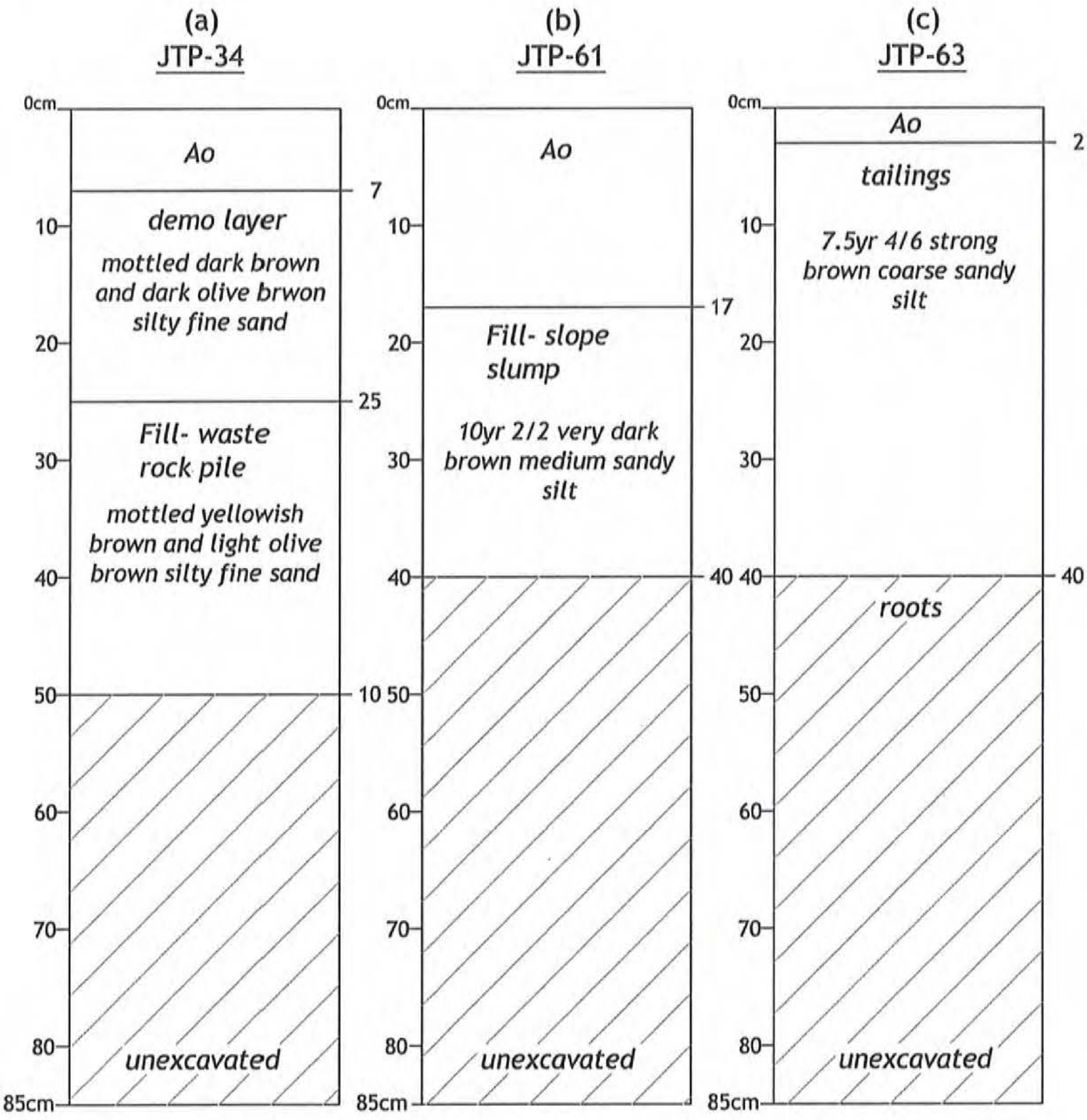

Figure 8-17. Representative test pit profiles in the Union and Eureka mine offices areas.

brick fragments, two wire nails, and one piece of wood. Of particular interest was the recovery of 19 fragments of schist drill cores in proximity to the foundation. The discovery of drill cores at the office foundation supports its dual use for storage of geological testing equipment by one or more of the mine companies.

Table 8-3. Count of Cultural Material Recovered from the Union Mine Office Area.

Material	Count
Brick	6
Glass	125
Iron	2
Schist	19
Wood	1
Total:	**153**

The Eureka Office (Foundation 42) is located 175 ft (53.3 m) south of the Union Office foundation, and only 40 ft (12.1 m) west of the base of the ore mill. It measures 25-x-40 ft (7.6-x-12.2 m) in whole, but the cellar constitutes only the northern half, measuring about 20-x-25 ft (6.1-x-7.6 m). The remaining half of the foundation is a platform area equal in square feet to the cellar. It is presently filled with slope wash and tailings.

Three test pits (JTPs 61–63) were placed in and around the Eureka Office foundation (Figure 8-18). The test pits revealed the presence of slopewash/fill and tailings from just under the duff to the limit of excavation between 40 and 70 cmbs (see Figures 8-17b, 8-17c). The testing recovered a total of 39 cultural materials in two of the test pits from 0 to 70 cmbs in the duff and fill deposits (Table 8-4 and Appendix A). These materials include machine-cut and wire nails (n=23) along with 14 pieces of flat (probably window) glass, one wood fragment, and one whiteware ceramic sherd. JTP 62 was located immediately south of the foundation in tailings and did not yield any cultural materials.

Table 8-4. Count of Cultural Materials Recovered from the Eureka Mine Office Area.

Material	Count
Glass	14
Iron	23
Whiteware	1
Wood	1
Total:	**39**

New Row

The New Row is the northernmost mine-related domestic subsite within the APE. It is located on a wooded secondary growth elevated knoll, which can still only be accessed from Road 2 as it climbs westward from Richardson Road past the Lower Row area. There is no evidence of any vehicular road access to the New Row. Instead it was likely accessed directly off Road 2 by a foot path (no longer

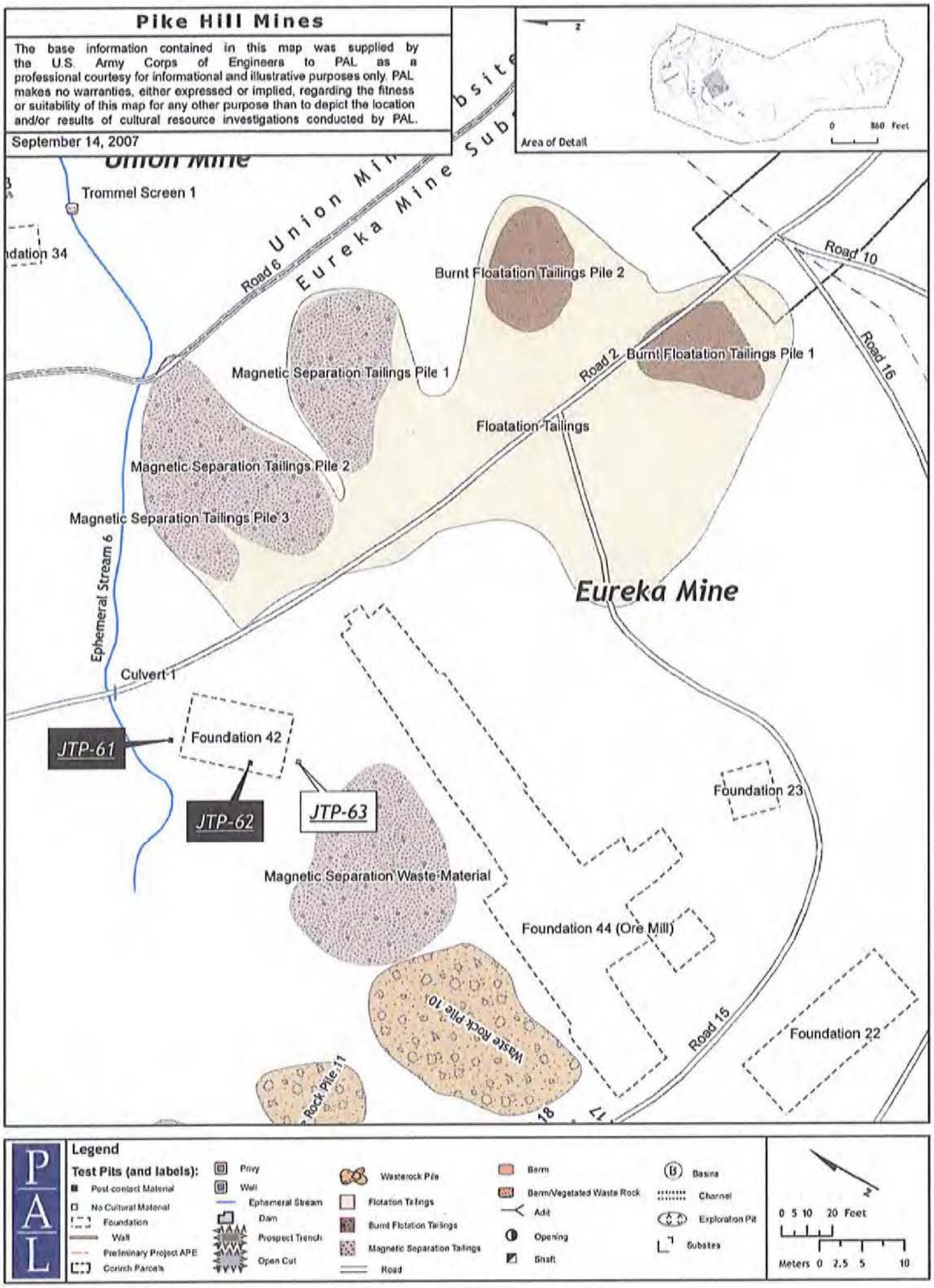

Figure 8-18. Detail plan of Eureka Mine Office (Foundation 42) testing area.

visible). The New Row structure is depicted in the ca. 1880 photographs of the site. It comprised a long, one-story building with small dormers in the east roof line and access to each of the documented 11 housing units by an exterior door in the east (front) elevation (see Figure 5-4). There were also 11 attached enclosed stoops/sheds on the rear (west) elevation that would have provided access to four communal outhouses, also visible in the ca. 1880 photographs (see Figures 5-7 and 5-8). Narrow chimneys (possible heating stove vents) are also apparent in the building roof-line. The current survey identified this subsite as encompassing the linear foundation remains of this "dormitory" structure within an approximate 2-acre area (see Figure 2-4). These foundation remains are situated at about the 1,684 ft contour and are oriented in a northwest-southeast direction (Figure 8-19), similar to the Lower and Upper Row foundations. It is difficult to determine to what extent the hillside was altered to support the dormitory, but it is likely that, in addition to selecting a location with minimal slope on the hill, fill was brought in to level off the area. The slope of the hillside in this area ranges from 0 to 40 percent.

The only structure identified in this subsite is Foundation 15, which constitutes the remains of the New Row dormitory. It measures 15-x-275 ft (4.6-x-88.8 m) and ranges from 2 ft (0.6 m) to 8 ft (2.4 m) in depth (Figure 8-20). There is a massive earthen berm that provides the downslope (north, south, and east sides) support for the foundation walls. Unlike the domestic structures in the Lower and Upper Rows, Foundation 15 is mostly constructed with massive granite stones, some measuring over 8 cubic feet. Also unlike the other domestic single-family and duplex structures, the foundation retains a great deal of integrity in terms of visible stonework and very little debris or overburden cover (Figure 8-21). All of the visible courses of stonework are dry-laid; there is no evidence of mortar material. The stonework is also elevated in relation to the surrounding exterior ground surface (Figure 8-22).

The exposed and massive Foundation 15 is clearly visible in the ca. 1880 photograph of the site. A raised boardwalk or wooden platform supported by posts would have been needed to provide access into the eastern elevation doorways. There were no visible remains of any such structure adjacent to the foundation's east elevation, although the area between the foundation wall and the supporting berm is sufficient for such a structure. The cellar hole of the foundation does not contain any interior wall divisions, so it would appear that the structure had one long, crawl space accessed from a single opening. This opening may have been positioned at the south side of the structure, as evidenced by the presence of an ell-shaped stone wall extension. The faint outline of what may be a cellar bulkhead appears at this side of the dormitory structure in the ca. 1880 photographs.

Privy 4 is located about one-third of the way north along the western wall of the foundation. It is comprised of a rectangular depression, measuring roughly 11-x-20 ft (3.5-x-6.1 m). A few fieldstones are visible in the sidewalls of the depression, which is about 2 ft (0.6 m) deep in the center. The privy is set back about 3 ft (0.9 m) from the outer foundation wall. The ca. 1880 photographs depict at least four outhouses on the west (rear) side of the dormitory structure. Two other squarish depressions are present adjacent to the northern third of the west (rear) foundation wall (exterior side). These depressions each measure about 11-x-11 ft (3.5-x-3.5 m) and appear to have been built against the side of the outer foundation wall. They may represent the remains of the enclosed stoops/sheds visible in the ca. 1880 photographs.

A possible, unfinished excavation for a second dormitory structure is located about 220 ft (67 m) east and downslope of Foundation 15. This rectilinear depression measures about 40-x-160 ft (12-x-48 m), and is void of any visible stonework. A depression nearly identical to the size, shape, and location of this feature is discernable in the ca. 1880 photograph that depicts the New Row dormitory (see Figure 5-4). It

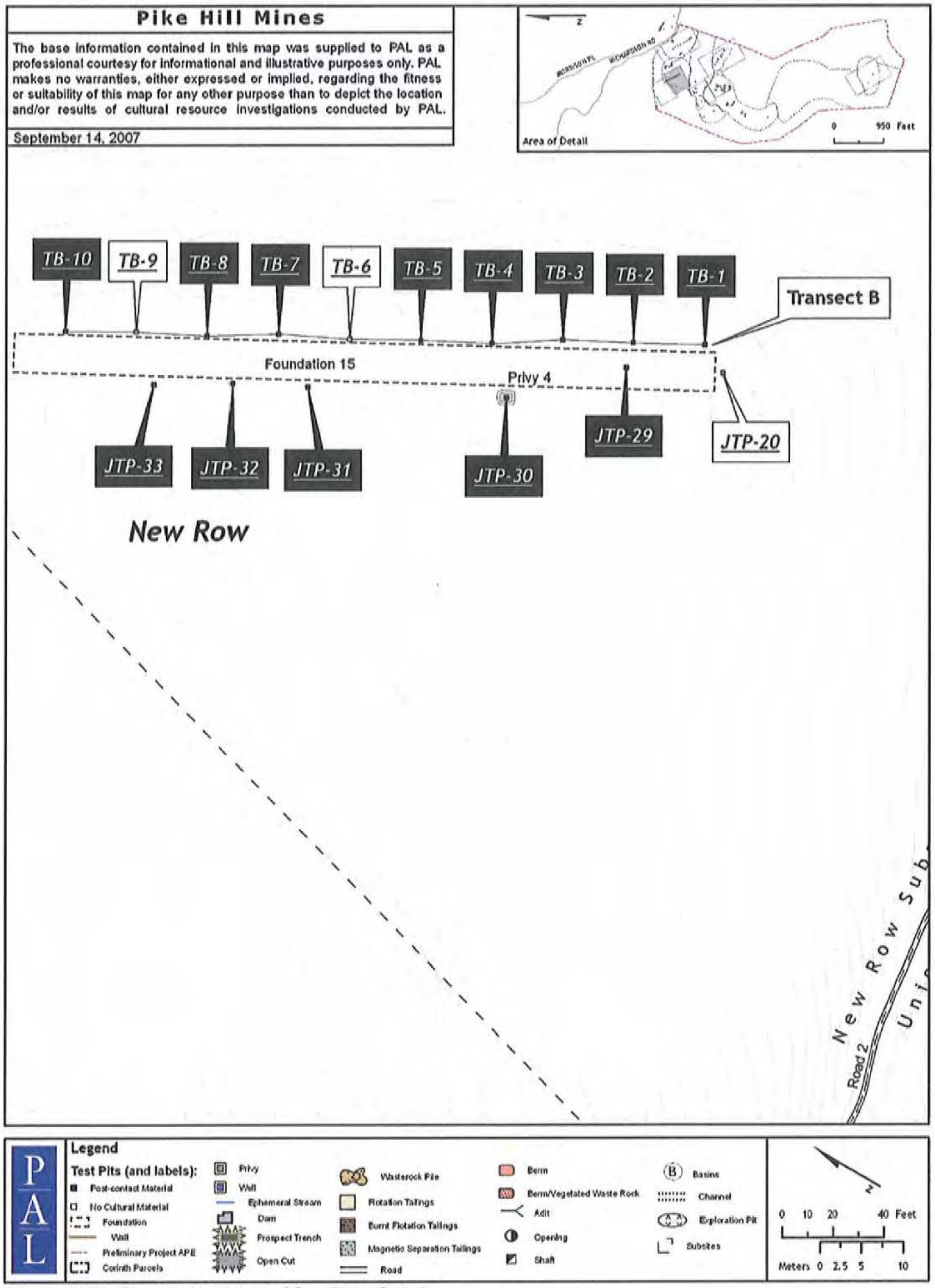

Figure 8-19. Detail plan of the New Row Subsite.

Figure 8-19. Detail plan of the New Row Subsite.

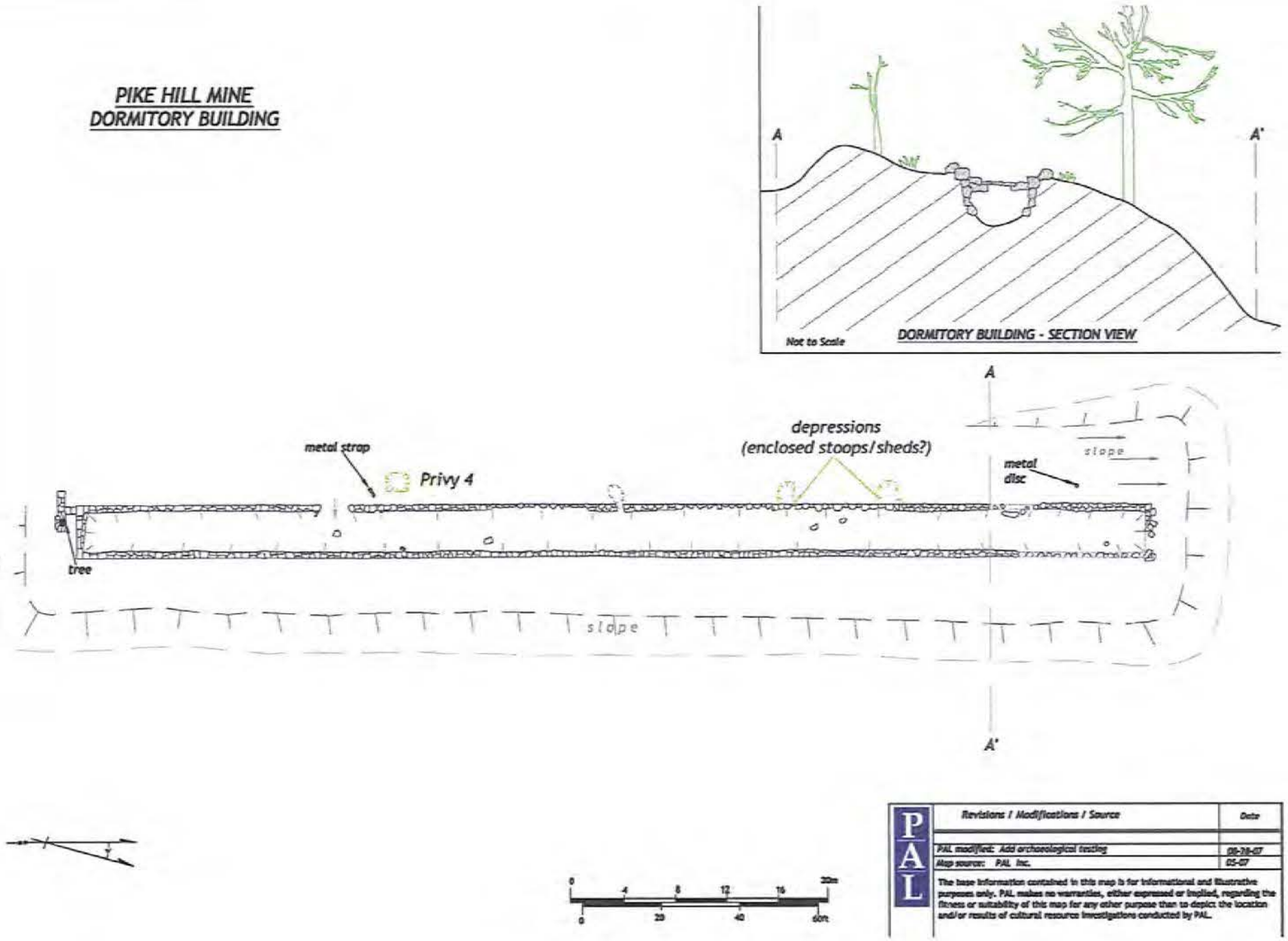

Figure 8-20. Detail plan and profile of Foundation 15 (dormitory).

Figure 8-21. Current photograph of Foundation 15 (dormitory), view looking south.

Figure 8-22. Current photograph of Foundation 15 (dormitory), showing raised east wall elevation, view looking southeast.

may be that a second dormitory was started in this year, but no progress was made before the mine workings shut down in 1882. A small structure appears in this same photograph near the upslope side behind this depression, but no physical evidence was identified during the survey.

Fifteen test pits were excavated around Foundation 15 in the New Row Subsite. This testing consisted of six judgmental test pits (JTPs 20, 29–33) placed along the south and west sides of the foundations and the privy depressions. One transect (Transect B) containing 10 test pits was placed along the east side of the foundation between the stone wall and the berm along the slope. One of the test pits, JTP 29, was excavated inside the southern part of the cellar hole. The Transect B soil profiles revealed the presence of various fill layers probably resulting from cellar hole ejecta as well as material brought in to level the downslope side of the foundation and create the earthen berm. A typical soil profile consists of about 5 cm of duff, overlying dark brown (10 YR 3/3) to very dark gray-brown (10YR 3/2) sandy silt to the average depth of excavation at 68 cmbs (Figures 8-23a, 8-23b). These test pits either terminated on rocks (bedrock ledge?) or in deep fill deposits that continued beyond the limit of hand excavation. The remaining test pits to the south and west also contained similar fill deposits that either terminated on ledge or extended below the limit of hand excavation (Figures 8-23c, 8-23d). JTP 29 contained dark brown silty sand fill deposits to 35 cmbs at bedrock ledge, which may have served as the interior ground surface of the cellar crawl space (Figure 8-23e).

This testing resulted in the recovery of 178 cultural materials in the various fill deposits encountered in and around the foundation and privy features from 0 to 50 cmbs (Table 8-5 and Appendix A). Glass (n=72) (mostly window [n=65]) and iron hardware (machine cut, square, wire nails) (n=95) comprised the

Table 8-5. Count of Cultural Materials Recovered from the New Row Subsite.

New Row

Material	**Count**
Brick	3
Glass	72
Iron	95
Leather	1
Metal	3
Mortar	2
Porcelain	1
Wood	1
Total:	**178**

highest percentage of recovered cultural materials from this subsite. Other construction materials include three brick fragments and two pieces of mortar. Ceramics are limited to one porcelain sherd and personal items consist of one piece of shoe leather. The relative lack of household and personal items suggests that either the dormitory was occupied for a very short period of time by few individuals (not families), and/or that the individual(s) had very little personal belongings and did not do any eating/cooking in the structure. The apparent lack of household debris and food waste supports the idea that the occupants' meals were taken in some other centralized location at the mine, although no such "mess hall" facility was identified in the documentary or archaeological records for the Pike Hill Mines Site.

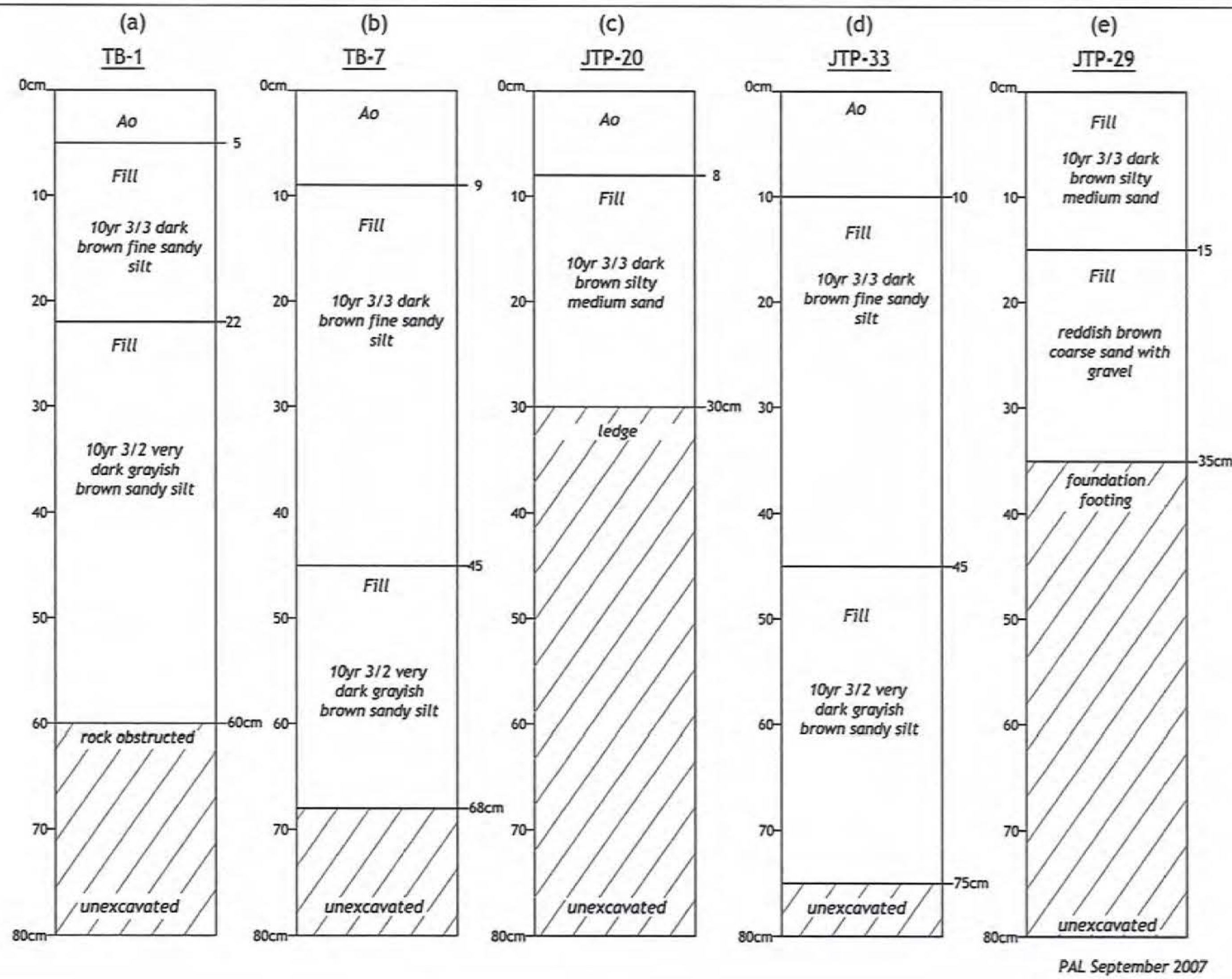

Figure 8-23. Representative test pit profiles in the New Row Subsite.

Non-Subsite Testing Areas

Several well-drained terraces overlooking ephemeral stream drainages in the areas north and northeast of the New Row Subsite were targeted for pre-contact archaeological testing (see Figure 2-4). Transects D and E were both located less than 250 ft (76.2 m) from the northern end of Foundation 15 (Figure 8-24). Transect D, containing three test pits, was placed on a terrace at 1,742 ft amsl overlooking Ephemeral Stream 5, while Transect E, containing two test pits, was placed on a terrace at 1,680 ft amsl directly alongside the stream. No cultural materials were recovered in any of these test pits. Soil profiles indicate the presence of natural A and B horizons in this area (Figures 8-25a, 8-25b). The A horizon averages 18 cmbs and consists of very dark brown (10 YR 2/2) fine sandy silt. The B horizon extends below the limit of hand excavation and consists of a dark brown (10 YR 3/3) sandy silt.

Transect C was placed about 240 ft (73 m) upslope (southwest) on a higher terrace that overlooked the same Ephemeral Stream 5 drainage in this part of the site (see Figure 8-24). It contained five test pits, none of which yielded any cultural materials. Soil profiles in this area also revealed the presence of natural A and B horizons (Figure 8-25c). The A horizon averages 27 cmbs and consists of a very dark brown (10 YR 2/2) fine sandy silt. The B horizon extends below the limit of hand excavation and consists of a dark gray-brown (10 YR 4/2) silt.

Transect F was placed in this same central part of the overall site. It was located on another secondary terrace overlooking Ephemeral Stream 5, but farther southeast downslope (see Figure 8-24). It contained four test pits, none of which yielded any cultural materials. Soil profiles in this area also revealed the presence of natural A and B (and possibly C) horizons (8-25d). The A horizon averages 16 cmbs and consists of a very dark brown (10 YR 2/2) fine sandy silt. The B horizon extends below the limit of hand excavation and consists of a dark brown (10 YR 3/3) silty sand in the upper levels and a possible B_2/C horizon consisting of an olive-brown (5 Y 6/6) sandy silt.

Non-Site Domestic Resources

Several visible foundations were mapped on the east side of Richardson Road, opposite the Pike Hill Mines village general store and Lower Row Subsite. These foundations were initially thought to be associated with the mine village, but further review of available written and cartographic/photographic sources indicate that these are more likely the remains of private farmsteads that were occupied in the nineteenth-century before, during, and after the mines' activities at Pike Hill (see Chapter 5-nonmining historical context). Five foundations, a well, and a secondary town road (Road 14) were mapped in this wooded area along Richardson Road, opposite the mine entrance (see Figure 2-4).

Foundation 14 is located on a small terrace 80 ft (24.4 m) east of Richardson Road and approximately 200 ft (60.9 m) east of the mine entrance Road 2. Foundation 16 is located 200 ft (60.9 m) east of Foundation 14 and measures 10-x-15 ft (3.1-x-4.5 m). It most likely functioned as a small storage shed/outbuilding related to the larger connected farmstead site. Well 3, approximately 3-ft (1 m) in diameter and made of dry-laid fieldstones, is situated about 100 ft (30.5 m) north of Foundation 14.

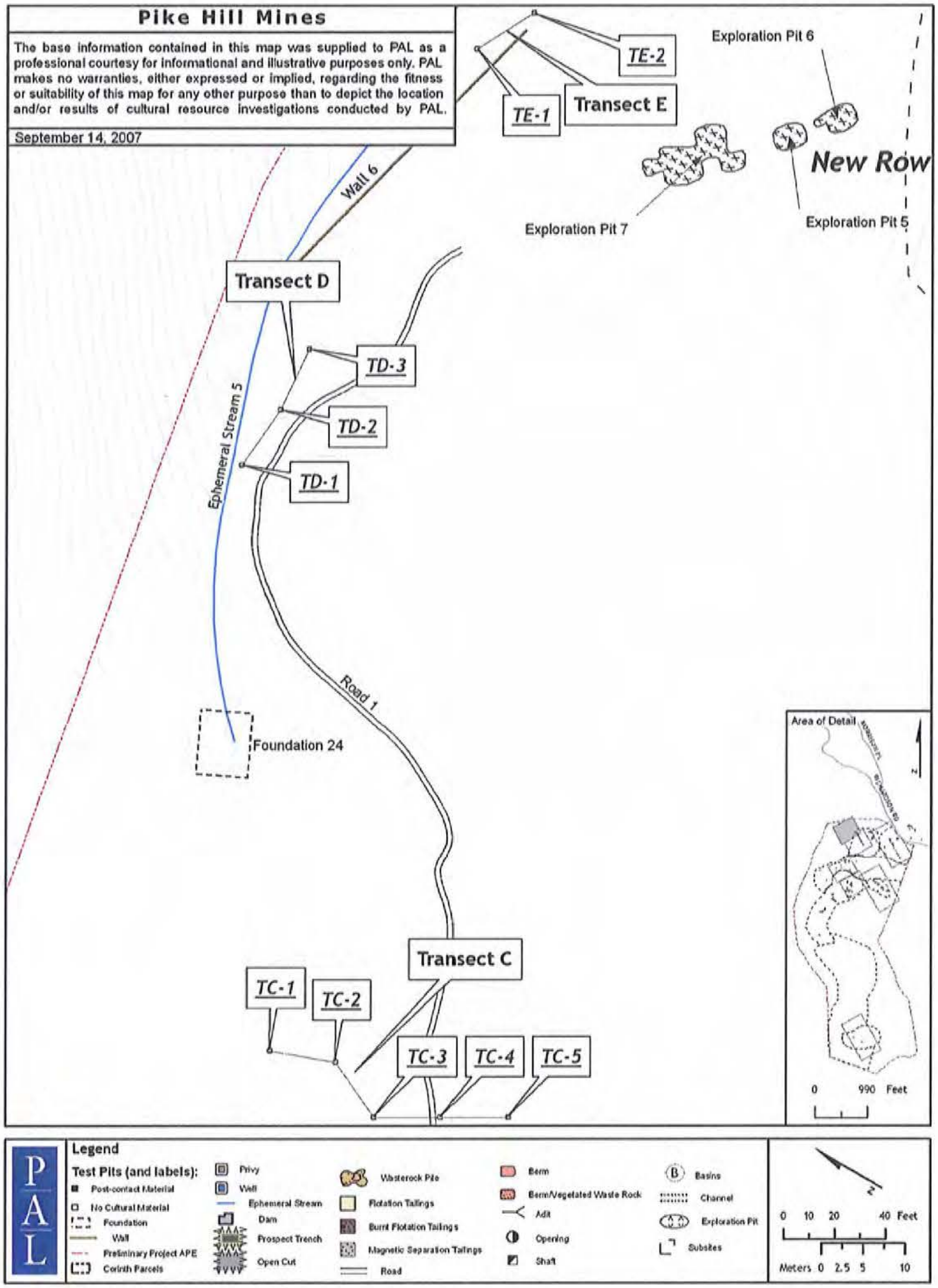

Figure 8-24. Detail plan of non-site testing areas north and west of the New Row Subsite.

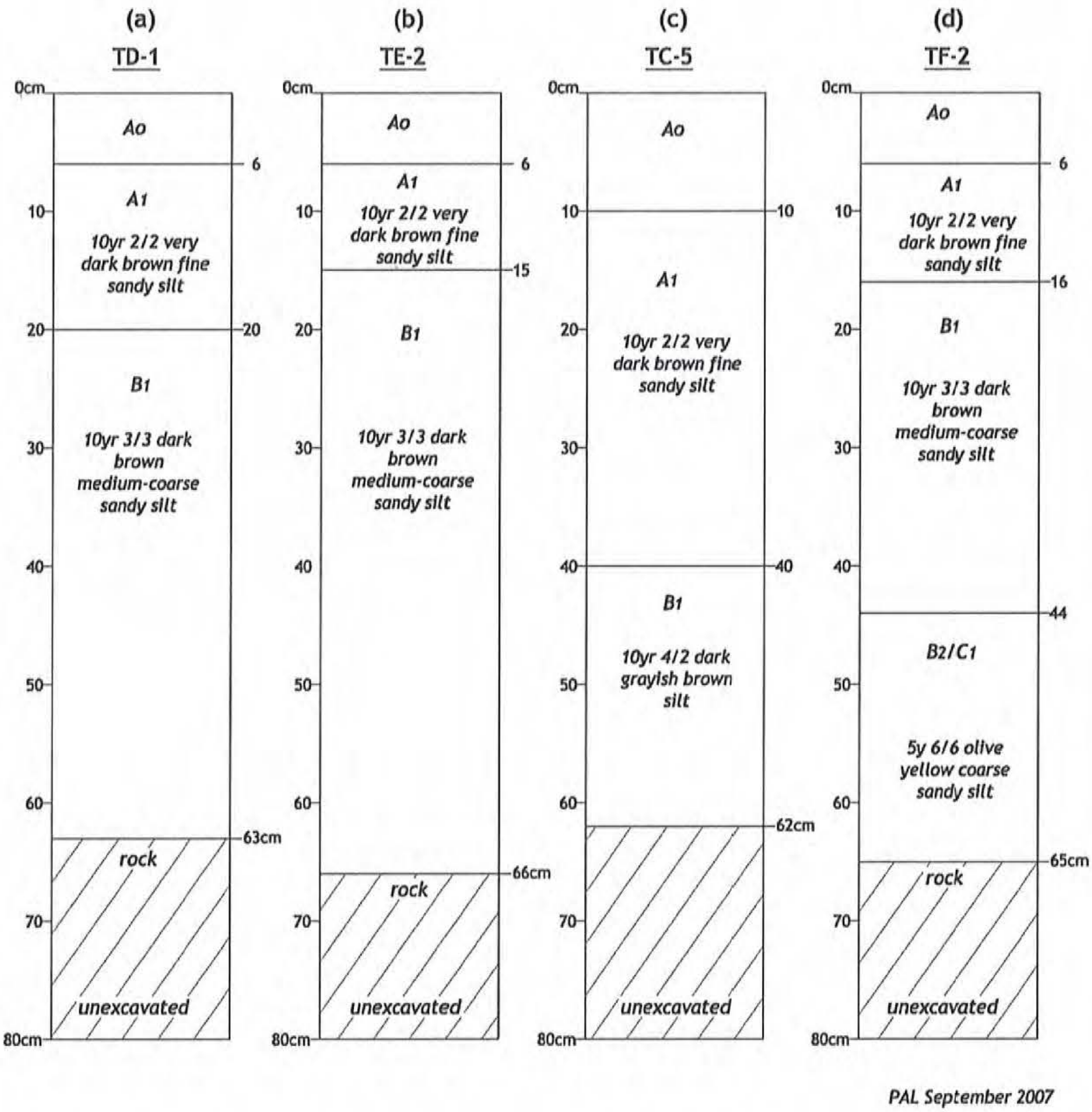

Figure 8-25. Representative soil profiles for non-subsite testing areas.

Foundations 17, 18, and 20 are arranged in a linear alignment fronting the east side of Road 14. They appear to represent a connected farmstead structure in that Foundation 20 is large enough to have been a barn, measuring 60-x-80 ft (18.3-x-24.4 m), constructed on an artificial terrace, and Foundations 17 and 18 are smaller and both have cellar hole components and central chimney bases indicative of dwellings. Foundation 17 measures 30-x-40 ft (9.1-x-12.1 m) and Foundation 18 measures 20-x-30 ft (6.1-x-9.1 m). The cellar holes range from 3 ft (0.9 m) to 5 ft (1.5 m) in depth with several exposed courses of dry-laid schist and granite.

CHAPTER NINE

SUMMARY/CONCLUSIONS AND RECOMMENDATIONS

Summary/Conclusions

Pre-Contact Period Resources

The fieldwork completed as part of the current historic and archaeological investigations did not identify any pre-contact period cultural resources within the Pike Hill Mines project APE. Nineteen percent of the subsurface testing conducted within the 173-acre preliminary project APE was used to investigate areas determined to have pre-contact habitation site potential based on the VDHP's environmental predictive model and ArcheoMapping tool. The absence of Native American cultural deposits in tested portions of the project APE suggests that the land use patterns in the vicinity of the Waits River/Pike Hill stream drainage reflect sporadic, short-term occupations. This type of low visibility settlement pattern may have continued into the Contact and early historic periods.

Historic Period Resources

The current survey included documentary research and field investigations to identify and record visible cultural features associated with the industrial and domestic occupations at the Pike Hill Mines Site. The documentary research consisted primarily of a synthesis of information collected to date for the mine site (see Chapter 2 discussion of archival sources), along with additional contextual data about the historical development of the surrounding community. The field investigations recorded 241 distinct cultural features within the 173-acre preliminary project APE depicted on project maps. All of these features are within the mining period of site occupation, but some may pre- and post-date the industrial occupations. The GIS database for the recorded features including temporal affiliation is included as a technical appendix in the report (see Appendix E).

In general, the majority of the Pike Hill Mines historic landscape, including extensive remains of both industrial and domestic resources, is well preserved in the preliminary project APE. Some of these resources have undergone varying degrees of historic and modern period impacts from both natural processes and human intervention. Natural processes include erosion, some accelerated by adaptive land re-uses and vegetation regrowth. Man-made processes include the creation of an informal parking area off Richardson Road in the area of the mine's General Store, post-mine period (mid-twentieth century) dumping in the Upper Domestics site area and other more recent activities of private landowners including the creation of logging and access roads and tree and stump removal. Other disturbances resulted from extinguishing the ore mill flotation tailings fire discovered in the early 1980s. No looting or other types of intentional disturbances to destroy historic and archaeological resources were noted within the project APE.

Industrial Resources

Each of the four industrial subsites and miscellaneous industrial resources have been interpreted and assessed in terms of their internal complexity and physical integrity. For the most part, the identified foundations and features associated with these subsites have undergone some degree of natural erosion from tree regrowth and frost heave that have caused wall slumpage and tumble of foundation stones. These natural processes are quite typical at rural New England historic sites, and as such are not considered to have compromised the integrity of the resources. The historical research value including documentary data and archaeological sensitivity of each subsite is also included in this discussion. In general, the documentary record is considered to be poor to fair for the overall site, since there are numerous information gaps in terms of precise construction dates, underground mine workings, date ranges of industrial activities, and internal building function(s) and ore beneficiation processes. A summary of these identified resources is presented in Table 9-1.

Union Mine: Shaft/Adit Area

This subsite area contains a mine shaft, adit, hoist house foundation and machinery pads, two open cuts, one prospect trench, water collection features, and six stone foundations associated with mining and haulage of ore. The period of activity for this area is estimated to be ca. 1854 to ca. 1882. There is some limited historical archival and photographic documentation for this area. All of the visible features are in good physical condition. There is no evidence of post-mine occupation dumping or disturbances to these remains. There are no recent disturbances or immediate natural or artificial threats to their integrity. The Shaft/Adit Area, situated on land currently owned by John and Nancy L. Ayers, has moderate potential to contain archaeological deposits that could address important research topics related to the Union Mine underground mining, ore haulage, hoisting activity, and associated equipment.

Union Mine: Upper Cobbing House Area

This subsite area contains stone foundations, stone walls, waste rock piles, a masonry dam, vegetated and barren waste rock piles, and mine roads associated with haulage and surface treatment of ore. The period of activity for this area is estimated to be ca. 1854 to ca. 1882. There is some limited historic archival and photographic documentation for this area. All of the visible features are in poor to fair physical condition. There is no evidence of post-mine occupation dumping or disturbances to these remains. There are no recent disturbances or immediate natural or artificial threats to their integrity. The Upper Cobbing House Area, situated on land currently owned by John and Nancy L. Ayers, has moderate potential to contain archaeological deposits that could address important research topics related to the Union Mine ore processing, and mining activity and impact on the landscape.

Union Mine: Waste Rock/Walls/Foundations Area

This subsite area contains stone foundations, stone walls, vegetated and barren waste rock piles, and ore processing machinery parts associated with processing copper ore. The period of activity for this area is estimated to be ca. 1854 to ca. 1882. There is very limited historical photographic documentation for this area. All of the visible features are in poor to fair physical condition. There is no evidence of post-mine occupation dumping or disturbances to these remains. There are no recent disturbances or immediate natural or artificial threats to their integrity. The Waste Rock/Walls/Foundations Area, situated on land

Table 9-1. Summary of Historic Industrial Resource Areas and Subsites Identified Within the Pike Hill Mines Site.

Subsite: Location/Area (Property Owner)	Time Period	Major Visible Physical Remains	Subsurface Testing/ Cultural Materials	Integrity[1]	Historical Research Value		
					Documentary Data[2]	Archaeological Sensitivity	Interpretive Potential
Union Mine (John & Nancy L. Ayers)	ca. 1854 – ca. 1882	see below for each subarea of the subsite					
Shaft/Adit Area	ca. 1854 – ca. 1882	Mine shaft, adit, hoist house foundation and machinery pads, 2 open cuts, 1 prospect trench, water collection features, and six stone bldg. foundations	None	Good	Poor to fair	Moderate	Underground mining; ore haulage; hoisting activity and associated equipment
Upper Cobbing House Area	ca. 1854 – ca. 1882	Stone foundations, stone walls, masonry dam, vegetated and unvegetated waste rock piles	None	Fair to Good	Poor to fair	Moderate	Ore processing; mining activity and impact on landscape
Waste Rock/ Walls/Foundations Area	ca. 1854 – ca. 1882	Stone foundations, stone walls, vegetated and unvegetated waste rock piles, ore processing machinery parts	None	Poor to Fair	Poor to fair	Moderate	Ore processing and associated equipment; mining activity and impact on landscape
Lower Cobbing House Area	ca. 1879 – ca. 1882	Stone foundations, stone walls, waste rock piles, earth ramp, haulage roads	None	Poor to Fair	Poor to fair	Moderate	Ore processing; mining activity and impact on landscape
Eureka Mine (John & Nancy L. Ayers)	ca. 1854 – ca. 1919	see below for each subarea of the subsite					
Cuprum Cut/Shaft Area	ca. 1854 – ca. 1919	Open cut, exploration pits, one shaft, stone foundation and platform, waste rock piles, mine roads	None	Good	Poor to fair	Moderate to High	Underground mining; ore haulage; hoisting activity and associated equipment; mining activity and impact on landscape

Table 9-1. Summary of Historic Industrial Resource Areas and Subsites Identified Within the Pike Hill Mines Site.

Subsite: Location/Area (Property Owner)	**Time Period**	**Major Visible Physical Remains**	**Subsurface Testing/ Cultural Materials**	**Integrity[1]**	**Historical Research Value**		
					Documentary Data[2]	**Archaeological Sensitivity**	**Interpretive Potential**
Eureka Shaft/Upper Adit Area	ca. 1863 – ca. 1919	Two open cuts, one adit, one shaft, two stone foundations, earth and stone ramp, mine roads, and waste rock piles	None	Fair to Good	Poor to fair	Moderate to High	Underground mining; ore haulage; hoisting activity and associated equipment; mining activity and impact on landscape
Eureka Lower Adit/Blacksmith Shop Area	ca. 1863 – ca. 1919	Adit, stone walls, stone foundations (including blacksmith shop), blacksmith forge and associated features, ore carts, waste rock piles, and mine roads	None	Good to Excellent	Poor to fair	High	Mine support/service activities; mining activity and impact on landscape; underground mining; ore haulage
Eureka Ore Mill	ca. 1905 – ca. 1919	Stone foundations – ore mill and reservoirs, mine roads, waste rock piles, and differentiated mill tailings	None	Good to Excellent	Poor to fair	High	Mining activity and impact on landscape; ore beneficiation; associated power generation; and associated process and equipment
Prospect Trenches (Ayers; Gary D. Bahlkow)	ca. 1846? ca. 1907–ca. 1913?	Various prospect trenches	1 test pit; no cultural materials	Good	Poor to fair	Low	Mining activity and impact on landscape
Smtih Mine (Gary D. Bahlkow)	Ca. 1846 Ca. 1907-1913	Shaft, adit, stone well, stone foundations, waste rock piles, mine road	7 test pits – yielded a low density of cultural materials	Poor to fair	Poor to fair	Low	Mining activity and impact on landscape

Table 9-1. Summary of Historic Industrial Resource Areas and Subsites Identified Within the Pike Hill Mines Site.

Subsite: Location/Area (Property Owner)	Time Period	Major Visible Physical Remains	Subsurface Testing/ Cultural Materials	Integrity[1]	Historical Research Value		
					Documentary Data[2]	Archaeological Sensitivity	Interpretive Potential
Exploration Adit/Prospect Pits/Waste Rock Pile 39 Area (John & Nancy L. Ayers)	Ca. 1845 to ca. 1919?	Exploration pits, adit, waste rock pile, drainage channel	None	Fair	Poor to fair	Low	Mining activity and impact on landscape
Granite Quarry/Cutting Area (John & Nancy L. Ayers)	Early-mid 19th c.? Mine-related?	Quarried and cut granite materials, quarry pit	None	Good	Poor to fair	Low	Non-mine and/or mining activity and impact on landscape
Foundation 24 Area (John & Nancy L. Ayers)	Ca. 1880-1919	Stone foundation (reservoir)	None	Good	Poor to fair	Low	Mine support/service activities
Wall 6 and Wall 26 (John & Nancy L. Ayers)	Early-mid 19th c.?	Stone walls	None	Good	Poor to fair	Low	Non-mine and/or mining activity and impact on landscape
Exploration Pits 5, 6, 7 (John & Nancy L. Ayers)	Ca. 1845 to ca. 1880	Exploration pits	None	Good	Poor to fair	Low	Non-mine and/or mining activity and impact on landscape

[1] based on visual inspection only; does not include potential belowground resources

[2] based on known and expected available primary and secondary sources: company records, geological reports, anecdotal/travelers' accounts, historic maps and photographs,etc.

currently owned by John and Nancy L. Ayers, has moderate potential to contain archaeological deposits that could address important research topics related to the Union Mine ore processing and associated equipment, and mining activity and impact on the landscape.

Union Mine: Lower Cobbing House Area

This subsite area contains stone foundations, stone walls, waste rock piles, an earth ramp, and mine roads associated with haulage and surface treatment of ore. The period of activity for this area is estimated to be ca. 1879 to ca. 1882. There is some limited historical archival and photographic documentation for this area. All of the visible features are in poor to fair physical condition. There is no evidence of post-mine occupation dumping or disturbances to these remains. There are no recent disturbances or immediate natural or artificial threats to their integrity. The Lower Cobbing House Area, situated on land currently owned by John and Nancy L. Ayers, has moderate potential to contain archaeological deposits that could address important research topics related to the Union Mine ore haulage, and mining activity and impact on the landscape.

Eureka Mine: Cuprum Cut/Shaft Area

This subsite area contains an open cut, exploration pits, a shaft, stone foundations and platform, waste rock piles, and mine roads associated with underground mining, haulage, and surface treatment of ore. It also contains evidence of a gasoline-powered mine hoist engine. The period of activity for this area is estimated to be ca. 1854 to ca. 1919. There are no known historical maps or photographs that depict this area. All of the visible features are in good physical condition. There is no evidence of post-mine occupation dumping or disturbances to these remains. There are no recent disturbances or immediate natural or artificial threats to their integrity. The Cuprum Cut/Shaft Area, situated on land currently owned by John and Nancy L. Ayers, has moderate to high potential to contain archaeological deposits that could address important research topics related to the Eureka Mine underground mining, ore haulage, hoisting activity and associated equipment, and mining activity and impact on landscape.

Eureka Mine: Eureka Shaft/Upper Adit Area

This subsite area contains a mine shaft, collapsed adit, two open cuts, mine roads, waste rock piles, an earth and rock ramp, and stone foundations associated with underground mining, haulage, and surface treatment of ore. The period of activity for this area is estimated to be ca. 1863 to ca. 1919. There are no known historical maps or photographs that depict this area. All of the visible features are in fair to good physical condition. There is no evidence of post-mine occupation dumping or disturbances to these remains. There are no recent disturbances or immediate natural or artificial threats to their integrity. The Eureka Shaft/Upper Adit Area, situated on land currently owned by John and Nancy L. Ayers, has moderate to high potential to contain archaeological deposits that could address important research topics related to the Eureka Mine underground mining, ore haulage, hoisting activity and associated equipment, and mining activity and impact on landscape.

Eureka Mine: Eureka Lower Adit/Blacksmith Shop Area

This subsite area contains a mine adit, mine roads, waste rock piles, remains of an ore cart, and stone, brick, and concrete foundations and equipment associated with a blacksmith shop. The period of activity for this area is estimated to be ca. 1863 to ca. 1919. There is one historical photograph and corporate ledgers that partially document this area. All of the visible features are in good to excellent physical condition. There is no evidence of post-mine occupation dumping or disturbances to these remains. There are no recent disturbances or immediate natural or artificial threats to their integrity, with the exception of possible flotation tailings associated with extinguishing a tailings fire. The Eureka Lower Adit/Blacksmith Shop Area, situated on land currently owned by John and Nancy L. Ayers, has high potential to contain archaeological deposits that could address important research topics related to the Eureka Mine support/service activities, mining activity and impact on landscape, underground mining, and ore haulage.

Eureka Mine: Ore Mill Area

This subsite area contains stone, brick, and concrete foundations and machinery piers associated with an ore processing mill; stone reservoirs, mine roads, waste rock piles, and differentiated mill tailings deposits. The period of activity for this area is estimated to be ca. 1905 to ca. 1919. There are several historical photographs, process flowsheets, and corporate ledgers that partially document this site. All of the visible features are in good to excellent physical condition. There is no evidence of post-mine occupation dumping or disturbances to these remains. There are no recent disturbances or immediate natural or artificial threats to their integrity, with the exception of possible flotation tailings associated with extinguishing a tailings fire. The Ore Mill Area, situated on land currently owned by John and Nancy L. Ayers, has high potential to contain archaeological deposits that could address important research topics related to the Eureka Mine mining activity and impact on landscape, ore beneficiation, associated power generation, and associated processes and equipment.

Smith Mine

This subsite contains a shaft, an adit, a stone well, two stone foundations, a waste rock pile, and a mine road, all associated with underground copper ore mining and associated surface operations. The period of activity for this site is estimated to be ca. 1846, and ca. 1907 to ca. 1913. There are no known historical maps or photographs that depict this site. Seven test pits were dug, revealing a low density of primarily twentieth-century cultural materials. All of the visible features are in poor to fair physical condition. There is no evidence of post-mine occupation dumping or disturbances to these remains. There are no recent disturbances or immediate natural or artificial threats to their integrity. The Smith Mine site, situated on land currently owned by Gary D. Bahlkow and John and Nancy L. Ayers, has a low potential to contain archaeological deposits that could address important research topics related to the Eureka and Union mines mining activity and impact on landscape.

Prospect Trenches

This subsite contains a series of earth trenches dug to bedrock as part of exploration for deposits of copper ore. The period of activity for this site is estimated to be ca. 1846, and/or ca. 1907 to ca. 1913. There are no known historical maps or photographs that depict this site. One test pit was dug, revealing no cultural materials. All of the visible features are in good physical condition. There is no evidence of post-mine occupation dumping or disturbances to these remains. There are no recent disturbances or immediate natural or artificial threats to their integrity. The Prospect Trenches site, situated on land currently owned by Gary D. Bahlkow and John and Nancy L. Ayers, has a low potential to contain archaeological deposits that could address important research topics related to the Eureka and Union mines mining activity and impact on landscape.

Isolates: Exploration Adit/Prospect Pits/Waste Rock Pile 39

This subsite contains exploration pits, an adit, waste rock pile, and drainage channel, associated with exploration for outcrops of copper ore. The period of activity for this site is estimated to be ca. 1845 to ca. 1919. There are no known historical maps or photographs that depict this site. All of the visible features are in fair physical condition. There is no evidence of post-mine occupation dumping or disturbances to these remains. There are no recent disturbances or immediate natural or artificial threats to their integrity. The Exploration Adit/Prospect Pits/Waste Rock Pile 39 site, situated on land currently owned by John and Nancy L. Ayers, has a low potential to contain archaeological deposits that could address important research topics related to the Eureka and Union mines mining activity and impact on landscape.

Isolates: Granite Quarry/Cutting Area

This subsite contains a shallow rectangular stone quarrying pit and an adjacent area of cut stones and stone cutting debris associated with extraction of building stone. The period of activity for this site is estimated to be the early to mid-nineteenth century. There are no known historical maps or photographs that depict this site. All of the visible features are in good physical condition. There is no evidence of post-mine occupation dumping or disturbances to these remains. There are no recent disturbances or immediate natural or artificial threats to their integrity. The Granite Quarry/Cutting Area, situated on land currently owned by John and Nancy L. Ayers, has a low potential to contain archaeological deposits that could address important research topics related to non-mining and/or the Eureka and Union mining activity and impact on landscape.

Isolates: Foundation 24

This subsite contains one visible rectangular fieldstone wall straddling a small brook, probably a reservoir. The period of activity for this site is estimated to be ca. 1880 to 1919. There are no known historical maps or photographs that depict this site. All of the visible features are in good physical condition. There is no evidence of post-mine occupation dumping or disturbances to these remains. There are no recent disturbances or immediate natural or artificial threats to their integrity. Foundation 24 is situated on land currently owned by John and Nancy L. Ayers, has a low potential to contain archaeological deposits that could address important research topics related to the Eureka and Union mines support/service activities.

Isolates: Wall 6 and Wall 26

This subsite contains two visible sections of standing fieldstone walls, possibly marking property boundaries or agricultural fields. The period of activity for this site is estimated to be the early to mid-nineteenth century. There are no known historical maps or photographs that depict this site. All of the visible features are in good physical condition. There is no evidence of post-mine occupation dumping or disturbances to these remains. There are no recent disturbances or immediate natural or artificial threats to their integrity. These two walls, situated on land currently owned by John and Nancy L. Ayers, have a low potential to contain archaeological deposits that could address important research topics related to non-mining and/or the Eureka and Union mining activity and impact on landscape.

Isolates: Exploration Pits 5, 6, and 7

This subsite contains three visible rectilinear pits excavated in bedrock with associated waste rock piles, possibly associated with exploration for copper ore, or quarrying building stone. The date range of activity for this site is estimated to be ca. 1845 to ca. 1880. There are no known historical maps or photographs that depict this site. All of the visible features are in good physical condition. There is no evidence of post-mine occupation dumping or disturbances to these remains. There are no recent disturbances or immediate natural or artificial threats to their integrity. Exploration Pits 5, 6, and 7, situated on land currently owned by John and Nancy L. Ayers, have a low potential to contain archaeological deposits that could address important research topics related to non-mining and/or the Eureka and Union mining activity and impact on landscape.

Domestic Resources

Each of the three domestic subsites included in the preliminary project APE have been interpreted and assessed in terms of their internal complexity and physical integrity. For the most part, the identified foundations and features associated with these subsites have undergone some degree of natural erosion from tree regrowth and frost heave that have caused wall slumpage and tumble of foundation stones. These natural processes are quite typical at rural New England historic sites, and as such are not considered to have compromised the archaeological integrity of the resources. The historical research value including documentary data and archaeological sensitivity of each subsite is also included in this discussion. In general, the documentary record is considered to be poor to fair for the overall site, since there are numerous information gaps in terms of precise construction dates, date ranges of occupation, function(s), occupants, and interrelationships among the various village components. A summary of the identified domestic resources is presented in Table 9-2.

Upper Row

This subsite contains six visible fieldstone foundations, which appear in historical photographs of the site. The date range of occupation for this domestic subsite is estimated to be ca. 1863 to ca. 1907. According to the ca. 1880s photographs, the houses were all one-story wood-frame duplex-style dwellings, each with a double chimney. They extended along a linear terrace southwest of the mine workings area about midway up the northeast-facing hillside. Several privies appear in proximity to the houses in the site photographs, although only one was identified during the fieldwork along with one stone-lined well feature. There are no known historical maps that depict the layout of the Upper Row domestic subsite. All of the visible foundations and features are in fair to good physical condition, with some evidence of post-mine occupation residential dumping along the nearby hillside slope. There are no recent disturbances or immediate natural or artificial threats to their integrity. The Upper Row subsite, situated on land currently owned by John and Nancy L. Ayers, has a high potential to contain archaeological deposits that could address important research topics related to the Eureka and Union mines occupations including worker community infrastructure, social demographics, and health/sanitation/diet.

Lower Row

This subsite contains 10 visible fieldstone foundations, which appear in historical photographs of the site. The date range of occupation for this domestic subsite is estimated to be ca. 1863 to ca. 1907. According to the ca. 1880s photographs, the houses were all one-story wood-frame single-family dwellings, each with a center chimney. Nine of the structures extended along a linear terrace that overlooked a small

Table 9-2. Summary of Historic Domestic Mine-Related Resource Areas and Subsites Identified Within the Pike Hill Mines Site.

Location/Area (Property Owner)	Estimated Date of Occupation	Major Visible Physical Remains	Subsurface Testing/Cultural Materials	Integrity[1]	Historical Research Value		
					Documentary Data[2]	Archaeological Sensitivity	Priority Research Topics
Upper Row (John & Nancy L. Ayers)	ca. 1863-ca. 1919	6 stone foundations, 1 well, 1 privy; domestic trash dump	24 test pits – yielded a high density of mid-19th through mid-20th c. domestic and construction debris	Fair to Good	Poor to fair	High	Community infrastructure; health/sanitation/diet
Lower Row (John & Nancy L. Ayers)	ca. 1863-ca. 1919	10 stone foundations; 3 privies; 1 well; 1 stonewall	22 test pits - yielded moderate density of mid-to late 19th c. domestic and construction debris	Good to Excellent	Poor to fair	High	Community infrastructure; health/sanitation/diet
New Row (John & Nancy L. Ayers)	ca. 1878-1882 (possibly later)	1 long dormitory stone foundation, comprised of 11 units; 1 privy	15 test pits - yielded low density of mid-late 19th c. domestic and construction debris	Good to Excellent	Poor to fair	High	Community infrastructure; health/sanitation/diet
General Store (John & Nancy L. Ayers)	ca. 1863-ca. 1919	None	None	Possibly destroyed	Poor to fair	Low to moderate	Community infrastructure; health/sanitation/diet
School House (unknown)	ca. 1863-ca. 1919	Unknown location	None	Unknown	Poor to fair	Unknown	Community infrastructure
Union Mine Office	ca. 1863-ca. 1919	Stone foundation and wood floorboards, timbers	3 test pits – yielded a moderate density of mostly construction materials, also schist drill core fragments	Good to excellent	Poor to fair	High	Mine and village support/service activities
Eureka Mine Office	ca. 1863-ca. 1919	Partially filled cellar hole, some stonework	3 test pits – yielded a low density of construction materials, one whiteware sherd	Poor to fair	Poor to fair	Moderate	Mine and village support/service activities

[1] based on visual inspection conducted to date and/or limited subsurface testing
[2] based on known and expected available sources: land evidence and probate records, tax records, etc.; company records, anecdotal/travelers' accounts, historic maps and photographs, etc.

stream drainage and Richardson Road to the northeast. The tenth structure is set slightly back to the west. Several privies appear in proximity to the houses in the site photographs, three of which were identified during the fieldwork along with one stone-lined well feature and a stone wall. There are no known historical maps that depict the layout of the Lower Row domestic subsite. All of the visible foundations and features are in good to excellent physical condition. There is no evidence of post-mine occupation dumping or disturbances to these structural remains. There are no recent disturbances or immediate natural or artificial threats to their integrity. The Lower Row subsite, situated on land currently owned by John and Nancy L. Ayers, has a high potential to contain archaeological deposits that could address important research topics related to the Eureka and Union mines occupations including worker community infrastructure, social demographics, and health/sanitation/diet.

New Row

This subsite contains one long visible fieldstone foundation that represents the remains of a documented dormitory-type structure comprised of 11 attached units, which appears in historical photographs of the site. The date range of occupation for this domestic subsite is estimated to be ca. 1878 to 1882, although it may have been used during later mining campaigns until about ca. 1907. According to the ca. 1880s photographs, the dormitory was a one-story wood-frame building with small dormers in the east roof line and access to each of the 11 housing units by an exterior door in the east (front) elevation. There were also attached enclosed stoops/sheds, one for each unit, on the rear (west) elevation that would have provided access to four communal outhouses, all visible in the historical photographs. One of these privies was identified during the fieldwork along with depressions that could represent two of the enclosed stoop/sheds. There are no known historical maps that depict the layout of the New Row domestic subsite. The visible foundation remains and associated features are in good to excellent physical condition. There is no evidence of post-mine occupation dumping or disturbances to these structural remains. There are no recent disturbances or immediate natural or artificial threats to their integrity. The New Row subsite, situated on land currently owned by John and Nancy L. Ayers, has a high potential to contain archaeological deposits that could address important research topics related to the Eureka and Union mines occupations including worker community infrastructure, social demographics, and health/sanitation/diet.

General Store and School House

No visible remains of either of these documented structures were identified during the current field investigations. According to the ca. 1880s photographs, the general store was a one and one-half-story wood-frame structure with a covered porch along its east elevation, facing Richardson Road. The location of this mine village building is currently obscured by dirt and gravel fill placed for informal vehicular parking closest to the mine road entrance off Richardson Road. Since the building functioned as a general store, it probably had some sort of belowground (root) cellar for cold storage of foodstuffs. It is considered possible that foundation remains and associated artifacts are buried beneath the current parking area. Should such archaeological remains survive belowground, they have a high potential to address important research topics related to mine worker community infrastructure and health/sanitation/diet.

No documentary data was identified regarding the location or appearance of the mine village school house, except that it had a belfry and was sold and moved from its Richardson Road location by ca. 1907. It seems logical that the school would have been situated close to the General Store and Lower Row dwellings near Richardson Road, but no such structure appears in the ca. 1880s photographs of the site.

Additional archaeological research and subsurface testing could identify this structure's location, and any surviving remains would have the potential to contribute to an understanding of the mine worker community infrastructure at the site.

National Register Statements of Significance

The mining period industrial resources have been organized into four major subsites, which along with the three domestic resource subsites and a number of intersite and isolated resources, collectively form the Pike Hill Mines historic site. The Pike Hill Mines historic site is recommended eligible for listing in the National Register of Historic Places under Criteria A, C, and D. Under these criteria and in reference to federal documents[1] the mine is significant at the local, state and national level in areas including Commerce, Economics, Engineering, Industry, Invention and Historic Non-Aboriginal Archaeology. The application of the levels and areas of significance to this site are complex as they do not all apply for all phases of activity that took place during the approximately 75-year period of activity at the mine from about 1845 to 1919, which can be considered its period of significance.

<u>Criterion A: Associated with events that have made a significant contribution to the broad patterns of our history.</u>

The Pike Hill Mines Site is eligible for listing in the National Register of Historic Places under Criterion A at the local, state and national levels for its contributions to the history of Corinth, the State of Vermont and the United States. These areas of significance include commerce, economics, engineering, industry, invention, and labor. The Pike Hill mines (Eureka, Union, and Smith mines) were a significant component of the Orange County Copper Belt. In the late 1870s-early 1880s, the Union Mine contributed to output of Ely Mine, which was among one of the top ten producing U.S. copper mines at that time. The Eureka Mine was the site of the only successful implementation of magnetic ore separation technology within the Orange County Copper Belt. The Pike Hill Mines are significant as part of a regionally anomalous extractive industrial mono-economy that supported a small community akin to a Western mining town.

<u>Criterion C: That embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction.</u>

The Pike Hill Mines Site is eligible for listing in the National Register of Historic Places under Criterion C as it embodies the distinctive landscape, engineering and industrial resources that are characteristic of a mid-nineteenth- to early-twentieth-century American metal mining and processing site. The Pike Hill Mines Site is one of the larger, more intact historic mining sites in New England. Some of the site components may not be individually eligible for listing in the National Register; however, when taken as a whole, they comprise a significant and distinguishable entity. Application of Criterion C is understood and applied when a site is being considered eligible as a historic district. In a historic district, all

[1] The application of the National Register criteria to historic sites and the consideration of the significance of mining landscapes in general is covered in several documents issued by the U.S. Department of the Interior, including *National Register Bulletin 16A: How to Complete the National Register Registration Form*; *National Register Bulletin 42: Guidelines for Identifying, Evaluating, and Registering Historic Mining Properties; National Register Bulletin 36: Guidelines for Evaluating and Registering Historical Archaeological Sites and Districts; National Register Bulletin 30: Guidelines for Evaluating and Documenting Rural Historic Landscapes; and National Register Bulletin 32: Guidelines for Evaluating and Documenting Properties Associated with Significant Persons.* Additional discussion of the significance of historic industrial properties in general and mining landscapes in particular can be found in *Assessing Site Significance* (Hardesty, Donald L. and Barbara J. Little, Altamira Press, 2000).

resources associated with the history of the site and its period of significance are considered contributing elements to the district. These elements are included regardless of individual integrity. At the Pike Hill Mine Site, these elements include, but are not limited to, areas de-vegetated by mining activity, roads and other transportation routes, open cuts, pits, shafts, adits, tailings and waste rock piles, building foundations, and archaeological elements now visible or that may be present based on documentary sources including historical maps and photographs. The Eureka Mine Site includes the surviving remains of a magnetic separation and froth flotation ore processing mill, a highly unusual industrial archaeological resource for the eastern United States. Deposits of waste material are valuable historic resources as they are major landscape features that are expressive of mining and metallurgical technology.

Criterion D: That have yielded, or may be likely to yield, information important in prehistory or history.

The Pike Hill Mines Site is eligible for listing in the National Register of Historic Places under Criterion D for its potential to yield information important to history. Many of the components listed under Criterion C are known or potential archaeological resources, which automatically includes the Pike Hill Mines under Criterion D. The Pike Hill Mines Site has the potential to yield archaeological evidence of industrial and technological activities including copper ore mining, and beneficiation for almost 75 years. The domestic and processing sites also have the potential to reveal important information about the lifeways of nineteenth- and early-twentieth-century miners, including topics of community infrastructure and social demographics.

The Pike Hill Mines Site has been determined eligible as a contributing element of the Orange County Copper Belt historic district, which includes the Elizabeth and Ely mine sites.

In support of establishing the significance and National Register eligibility of the Pike Hill Mines Site, each of the identified subsites has been assessed in terms of priority research topics related to themes of industry and abandoned communities important to Vermont history (see Tables 9-1 and 9-2; see VDHP 2002:22). The research themes developed for the Pike Hill Mines Site are as follows:

1. Organization of and Modifications to the Industrial Landscape Over Time

The identified historic and archaeological resources at the Pike Hill Mines Site are all components of a larger, complex, integrated cultural landscape. The Pike Hill Mines Site is a single site composed of numerous temporally, functionally, historically and physically related industrial, domestic and administrative subsites. The man-made landscape is as important as the features and artifacts arranged within it. Mining landscapes can be characterized and distinguished by historic patterns of land use such as strip-mining, hydraulic mining, or open-pit mining; the spatial organization or layout of the landscape; characteristic cultural industrial landforms such as mine waste rock dumps and mill tailing flows; roads and pathways; vegetation patterns related to land use such as secondary growth of plants on mine waste rock dumps; clusters of distinctive buildings and structures such as those at mines and village settlements; and small-scale features such as mine claim markers, stone walls, or fences (Noble and Spude 1992). The cultural landscape at the Pike Hill Mines Site provides insights into the technological advances of copper mining, and informs about how the arrangement of features defined socioeconomic relations of the inhabitants. The Pike Hill Mines Site landscape took its form as a result of cultural, technological, and environmental factors.

The topography at Pike Hill and the shape and orientation of the orebody within its host rock played an important role in the development of the historical landscape. The ore cropped out in several places on the slope of Pike Hill. The bowl-shaped hillside, which includes springs and is the headwaters of Pike Hill Brook, provided an advantageous topography for the gravity and water-fed copper production process. As the orebody was located and access developed, activity followed the trend of the ore. The plunging shape of the orebody required new access points from progressively longer adits down the slope of Pike Hill during the mid-nineteenth century. In 1905 the topography of the hillside dictated placement of the Ore Mill, and the nearby, downslope deposition of tailings pumped in a water slurry.

The results of the copper mining and processing activity left behind visible and belowground landscape features at the site, the largest and most dramatic being the Open Cuts 1, 2, 3, 4, and 5; the Cuprum, Eureka and Union shafts; the Eureka Lower Adit and Union Adit; and several complexes of waste rock piles. Irrespective of the historical significance of the activities that took place there or the specific artifacts and features that these subsites contain, these landscapes are, in and of themselves, important historic resources. They represent large outdoor industrial artifacts of the historic attitudes of entrepreneurs and industrialists toward mineral resources and the environmental consequences of their extraction.

The Pike Hill landscape contains a particularly important industrial site. The Eureka Mine Ore Mill, a regionally unusual surviving metallic sulfide ore beneficiation site, was the only site of successful application of magnetic separation in the Orange County Copper Belt. The Pike Hill Mines landscape includes a variety of historic domestic archaeological resources that reflect different aspects of mining- (and perhaps some non-mining) associated human activity. The rich variety of domestic and administrative sites at several locations are evidence of the mine workers' and managers' lives.

All of these resource groups on Pike Hill were linked by transportation routes and/or materials handling and energy transmission systems. Traces of many roads are still visible, and these routes were vital for carrying ore and supplies. Water was important to operations and examples of dams, reservoirs, cisterns and wells remain on the landscape. Electrical power generated by steam, internal combustion, and transmitted from off site was used for materials handling and processing in the Ore Mill. These are all evidence of the linking systems and widespread human presence within the Ely Mine landscape.

2. Mining, Beneficiation, Power Generation, and Support Operations

The Pike Hill mines, as peripheral work settlements, were geographically isolated, impermanent, industrial sites, where obsolete equipment or practices potentially lingered. The use of a boiler shell for a blacksmith forge and an ore cart for a quenching tub certainly provide evidence of frugal recycling and adaptive reuse of industrial equipment. However, Pike Hill was also a place where then- cutting-edge technologies were employed, including magnetic separation, froth flotation, and the unusual application of a gas producer and Otto engine combination for generating mechanical and electrical power.

Known primary source information regarding industrial machinery and processes at the Pike Hill Mines Site is confined to several U.S. and Vermont government geological surveys, a handful of photographs from about 1880 and 1907, two surviving Pike Hill Mines Company letter copy books from 1906–1907, Ore Mill process flow charts from 1906 (partial) and 1918, and an ore beneficiation process description for the magnetic separation and froth flotation systems. By comparison, there is far more technical information available to interpret the industrial remains at the Elizabeth and Ely mines.

Interpretation of the industrial remains at Pike Hill relied heavily on careful examination of the limited primary source material, detailed field recordation, comparison of the field data with the primary and secondary, period mining technical literature, and comparison with similar findings from sites at the Elizabeth and Ely mines. Secondary literature interpreting mining archaeology is limited, with Eric Twitty's *Riches to Rust A Guide to Mining in the Old West* (Twitty 2002) a valuable recent addition to the archaeology of early mining sites.

The varying levels of primary and secondary technical literature and current archaeological literature associated with some classes of industrial equipment, combined with varying levels of visible evidence or integrity of the features within the Union Mine and Eureka Mine subsites, affected the level of understanding of the equipment they contained and how they functioned. The Union Mine Shaft hoist house, for instance, is one of the more understandable features, as analysis of the primary literature on Union Mine underground operations, secondary literature on mine hoists, and the integrity of the remaining machinery piers, resulted in a good understanding of the boiler house floor plan and contents, including the type of hoist engine and cable drum used. At the Union Mine Upper Cobbing House Area, Waste Rock Piles/Walls Foundations Area, and Lower Cobbing House Area, far less is known about the mechanical ore processing activities, or the function of several smaller building foundations. These areas could benefit from further archaeological investigations.

Several of the industrial resource areas identified within the Pike Hill Mines Site contain features that are less well-understood, but that clearly have the potential to reveal additional information about several specific areas of technology used at the mines. These include features associated with shaft hoisting equipment and operations, blacksmith shop support operations, and power generation equipment. Further archaeological investigations could provide opportunities to confirm equipment and processes at several areas at the Pike Hill Mines Site, further illuminating our understanding of the nature, type, location, configuration, and operation of this equipment at Pike Hill. There has been little or no post-mining disturbance of these areas, which increases the potential for them to contain valuable information.

The Eureka Mine Subsite also contains areas and features that warrant further archaeological investigations, including several features that are unique within the Orange County Copper District. At the Cuprum Cut/Shaft Area, historical literature indicates that the hoist house originally contained a "horse whim," an early primitive hoist powered by a draught animal. This feature currently contains the footings for an early-twentieth-century gasoline-powered hoist, the only example of this type of machinery recorded to date in the Orange County Copper District. The Cuprum Cut/Shaft Area also has the potential to contain a blacksmith shop and cobbing platform, possibly at the location of the fieldstone platform recorded north of the hoist house features. At the Eureka Shaft/Upper Adit Area, the historic literature indicates that a second gasoline hoist was located at the shaft. Archaeological investigations at Foundation 36 could confirm this, as well as the presence of remains associated with a second, earlier, horse whim. Archaeological investigations in this area could also confirm the function of Foundation 12 as a cobbing shed, blacksmith shop, or other function.

The Eureka Lower Adit/Blacksmith Shop Area contains the only visible, undisturbed blacksmith shop remains in the Orange County Copper District. Additional archaeology within and around the foundation has the potential to reveal additional information about the layout of a mine site blacksmith shop, particularly drill sharpening equipment location, as well as waste disposal practices. The Eureka Mine Ore Mill Area contains an unusual surviving eastern U.S. flotation mill, and is the site of the only successful application of magnetic separation in the Orange County Copper District. At the Ore Mill, the purpose and function of some machinery piers, particularly in the powerhouse section, remains unknown. Additional archaeology and survey to locate and document additional features in that area, combined with additional technical literature research, has the potential to provide additional information about power generation and transmission, including the use of a gas producer/Otto engine, also unique within the Orange County Copper District.

3. Mine Workers and Their Living Conditions at the Union and Eureka Mines – Pike Hill

General accounts of the U.S. mining industry point to myriad ways that mining companies actively shaped the labor force—including the construction of work "communities" (which encouraged a more sworkforce) and the division of work tasks based on ethnicity or job assignments. While work was the pervasive backdrop of life at the mine, efforts were clearly made to separate private and public spheres. However, little is known about miners' living conditions away from the work setting. This lack of information is not uncommon at industrial sites across the country and has attracted the attention of social historians and archaeologists in recent years (Beaudry and Mrozowski eds. 1987; Mrozowski and Handley 1997; Van Bueren ed. 2002a, 2002b). Archaeological studies of work settlements are often the only means to examine and enrich understandings of working and living conditions, class relations, and resistance in the nineteenth and early twentieth centuries (Paynter 1988; Paynter and McGuire 1991).

Social historians (George Murdock 1949) define "community" as a group of people living in the same place, interacting on a daily basis, and operating under a system of shared understandings. The Union and Eureka Mine community can be viewed as a *peripheral work settlement*, a term specifically intended to encompass company towns, work camps, and villages formed by groups of entrepreneurs as well as enclaves of camp followers and strikers that sprang up within or near work settlements (Van Bueren 2002a:2). The defining attributes of these communities include their narrow economic focus, relative geographic isolation, impermanence, and dependence on the global economy. Work communities tied to extractive ventures, such as the Union and Eureka mine copper ore extraction and processing campaigns, were necessary because of their dependence on global markets. The impermanence of such communities, in turn, limited the amount of economic and social investment made in the community. Settlements occupied for longer periods of time, in particular those with higher proportions of families, generally developed a wider range of amenities, social activities, and institutions than those used for shorter periods and occupied largely or solely by men.

The available documentary record for the Union and Eureka mines at Pike Hill is scant, particularly when compared to that of the Elizabeth Mine and Ely Mine worker villages. Research conducted by others (e.g., Collamer Abbott) for this mine site have not located much in the way of archival materials that could provide clues as to the daily lives of the people employed at the mine, their living conditions, or relationships with company managers and/or owners. There are no historical maps to identify the location and types of domestic village resources and there are only a few historical photographs that are known to have survived. It may be that there are private collections in the town of Corinth and elsewhere that could contain valuable documentary materials related to the mine workers at Pike Hill. Census records are probably also available that would provide some statistical data about the numbers of individuals, families, ethnicity, etc for the mining community during the different mine campaign periods of occupation. However, it is unknown whether there are any company records or other accounts that would provide information about the numbers of employees, their wages, and the layout and growth of the village. Very little is also known about how the nineteenth- and early-twentieth-century miners organized the domestic household, separated their public and private space, or coped with problems of health, diet, foodways, and provisions in general. Similarly, information relating to the non-miners – including wives, children, boarding house operators, and farmers – who supported the mine community is largely absent from the historical record.

Aboveground survey and mapping identified three intact and geographically distinct mine worker habitation areas across the landscape. These habitation areas include single family dwellings, duplexes, and a dormitory-style building unique to the Pike Hill Mine site. There was also reportedly a general store and a schoolhouse, although the archaeological remains of these structures are unidentified. These domestic structures were for the most part located in proximity to the industrial workings on the northeastern slopes of the hill, all on the southwest side of Richardson Road, a town-maintained road. The Upper Row, Lower Row, and New Row subsites have fair to excellent integrity even though the buildings themselves were removed from the mine site in the early twentieth century either shortly before or right after the last mining campaign ended in 1919 (see Table 9-2). Post-mining disturbances (local dumping of household refuse) appears limited to the Upper Row Subsite, which would have been accessible to local farms accessing former mining roads in the area. The archaeological remains of peripheral work communities such as these provide particularly rich opportunities for research into the evolution of relations between workers and entrepreneurs.

Community Infrastructure

The current documentary record (primarily historical photographs) provides some limited information regarding worker housing area relationships, counts, and exterior appearance, but details about the Union and Eureka Mines community infrastructure are completely lacking. The limited archival and archaeological data collected to date confirm that mine workers and probably managers at the mines lived in company housing provided at Pike Hill in proximity to the industrial operations. From the mine histories it appears that at least one of the Lower Row and Upper Row housing areas, and possibly both, were likely established around 1863 when mining activity resumed at Pike Hill with the commencement of underground operations under the direction of the Union Copper Mining Company. By 1868 the mine employed 35 men and shortly before it went bankrupt in 1877 the number of workers had reached 70. The two housing rows were located on the northeast slopes of Pike Hill and there were reportedly 11 dwellings at that time. With the purchase of the industrial operations by Smith Ely in 1879 and transfer of the mining operations to the much larger Vermont Copper Mining Company, the local work force expanded to 125 employees and additional housing was constructed. This housing including the New Row, a single 265 ft long building consisting of 11 attached tenements. It was built on the same northeast slope of the hill, but slightly north of the Upper and Lower Rows and north of the mine workings. There was also a general store that reopened during this period. These three housing areas, the Upper and Lower Rows and then the New Row dormitory, comprised the full extent of the archivally and archaeologically documented Pike Hill Mines village infrastructure. Some of the workers may have also lived in the surrounding area, including farmsteads along Richardson Road to the north. The presence of a schoolhouse in the mine village, which at the peak of the mine's prosperity had as many as 100 pupils, seems to suggest that the majority of the workers and their families lived right at the mines.

In 1882 the mines again closed and most of the workers and their families moved away. The schoolhouse was also reportedly sold and moved, and it is likely that the general store closed too. It is possible that the few managers and mine workers left to manage the intermittent operations in the ensuing years were housed in the Upper Row and/or even in makeshift rooms in the office buildings. Mining operations that needed a sizeable work force did not resume until 1905 when John Allen and Henry H. Knox incorporated as the Pike Hill Mines Company. Underground development at the Eureka Mine was pursued and a new general manager was hired. The addition of the ore processing mill and operations at this time would also have necessitated the hiring of additional employees, although no work force numbers are provided in the documentary records for this mining period of operation. When the two mines, Eureka and Union, were finally joined into one operation in 1916 when the Pike Hill Mines Company purchased the Union Mine property, the mine again employed 40 men and there was a shortage of labor. It is likely that these 40 men and any other itinerant workers that could be hired from the surrounding towns were housed in the Lower and Upper Row buildings and possibly in the New Row dormitory during this period. By 1919, however, all mining operations ceased for good, and photographs believed to possibly be from this period indicating that all the mine village housing had been removed. Only the general store was still standing in proximity to what was the Lower Row.

All three of the domestic resource areas identified within the Pike Hill Mines Site have the potential to address important questions relating to the community's infrastructure that are not described and/or may not be available in the archival record. Further archaeological investigations could provide information about the nature and type of structures and the actual builders and occupants of the Pike Hill mines village. No information is currently known about the actual period of construction and mining company responsible for building each of the documented living areas – the Lower Row, the Upper Row, and the New Row dormitory. In addition, the archaeological testing at the New Row dormitory did not identify any food waste or evidence of household debris that would indicate the occupants of the dormitory actually had their meals in this housing area. There is no documentary information to indicate that there was a central "mess" hall-type building, although a number of foundations of unknown function were identified around the mine workings and offices. It could be that one of these unknown foundations served as a central location for community meals and social events. Further archaeological investigations in the New Row housing area as well as in and around the unknown foundations could provide clues as to the full extent of living conditions/amenities associated with the height of the nineteenth-century mining operations, ca. 1863 to 1882.

The organized, linear nature of the Lower Row and Upper Row domestic resources at the Pike Hill Mines Site suggests the intent on the part of one (or more) of the mining companies to establish a structured community organization, based on orderly, planned housing areas. This type of community structure reflects a more paternalistic approach to the workers and their lives, both during and after the workday, and may have been imposed at Pike Hill by Smith Ely who had already established a very structured and organized mine village at the nearby Ely Mine in Vershire. Like at Ely Mine, the establishment of the New Row dormitory may also have been an attempt by Smith Ely to impose spatial separation of the housing areas by classes of workers, with the more prominent managers living closest to the Corinth town road, general store, and schoolhouse in the single family homes near Richardson Road (the Lower Row), other worker families housed in the duplexes closer to the industrial operations (the Upper Row), and lastly the itinerant, single men being housed dormitory style (small attached units) in the New Row. It is possible that these divisions were also based on the internal structure of the different mine companies operating simultaneously, miner/manager choice, job assignments, ethnicity, or other factors altogether.

Health, Sanitation, and Diet

Like at the nearby Elizabeth and Ely Mines, the Pike Hill Mines were historically situated in a remote, frontier, and physically harsh environment, yet very little is known about mine worker adaptation to this environment and the role that it played in the social and cultural variability among the housing areas. The domestic areas have the potential to provide archaeological data that reflect the process of adaptation by workers to the mine environment. Important information could be obtained about the ideology of health and sanitation and about how the mine company coped with problems of provisioning its workers and managers. Archaeological investigations of privies, wells, and refuse disposal areas would provide the most useful information to address health, sanitation, and diet at the mine site, and how these basic human needs might have changed or evolved over time. For example, the State of Vermont had regulated sanitation procedures by 1902, including regulations concerning the discharge of waste into streams (State of Vermont 1902:144–148). The ca. 1880 photographs show outhouses associated with all three housing areas in proximity to the single and duplex structures and the dormitory, although only the Lower Row privies seem to have drained into the nearby streams. The extent to which the various mine owners/management followed the state regulations is unclear, but it may be possible to determine what, if any, affect the 1902 law had on sanitation during the final two mining campaigns at the site.

Further archaeological investigations could be directed at identifying and investigating any wastewater control and material refuse features in relation to the domestic subsites, including the water system that included a number of spring-fed wells. The placement of such features in relation to each other and to the house sites would bear directly on the extent of sanitation practiced at the site. Archaeological investigations could also identify refuse deposits that provide clues as to whether waste was scattered around the sites, disposed of in designated areas, or incinerated to deter infestations by pests and to control odors, etc. The majority of the dumping identified to date at the Upper Row seems to have taken place post-mine abandonment and was most likely related to local farmsteads and not to the mining occupants themselves. The various methods of trash disposal identified in the housing areas would indicate an increasing level of organization, effort, and concern about the sanitation and appearance of the site, probably initiated by Smith Ely in the late 1870s and modeled after the highly structured worker village at his nearby Ely Mine Site.

The diet of the villagers also had an effect on the community. All of the bone recovered from belowground contexts (i.e., non-post-mining dumping areas) of the Lower and Upper Row subsites appears to have been from small mammals (i.e., birds). No larger mammal or butchered bone was recovered during the current archaeological investigations. Several barns are documented to have been present in the mine village, suggesting that some farm animals were kept, yet these may have been limited to and consisted primarily of poultry for meat and eggs. This is in stark contrast to the nearby Ely Mine Site, for example, where the majority of the recovered bones were cow and deer, some of which showed evidence of cutting by an experienced butcher in town. The lack of cow or pig bone and deer bone at the Pike Hill Mine domestics is intriguing since it would be expected that the miners here would have also needed/incorporated high protein meats into their diets. Further archaeological investigations at the Pike Hill Mine domestics would be expected to yield larger mammal bone, which could be indicative not only of a local supply source from the surrounding community but also that the miners engaged in hunting (deer) either for sport or to supplement their diet.

Further archaeological investigations would also be targeted at collecting fill soils from in and around the foundations and any identified privies to examine them for the presence of organic (e.g., seeds, nuts) that could provide evidence of the types of fruits and vegetables consumed by the mine workers. Archaeological investigations could also identify small garden plots around the Lower and Upper Row housing units. Such features would not only inform on subsistence patterns, but could also provide clues as to household structure and the role that non-miner family members (wives, children) may have played in the overall provisioning of the work force. The presence of such gardening activities at the New Row Subsite could also indicate that families were housed in the dormitory-style structure, which would contradict the preliminary interpretation of its function being limited to short-term itinerant male miners.

The farmstead site identified on the north side of Richardson Road, opposite the mine road entrance that led past the general store, schoolhouse, and Lower Row domestics could provide information about the effect the mine had on surrounding farms. This farm appears to pre-date the earliest underground mine workings, and could provide insight into the effect the development of the mine had on local agricultural concerns. Historical photographs indicate that this farm in particular continued to be occupied during all the mining campaigns and was still standing/occupied at the time of the final mine closing. The completeness of the historic remains at this farmsite is not currently known, since it was not included in the preliminary project APE. Should any cleanup work be needed in this area across Richardson Road, archaeological investigations would likely inform about the relationship between the mine and the surrounding community. The systematic investigations of non-industrial sites are useful in integrating the mine into the context of Corinth and the surrounding communities.

Recommendations

Pre-Contact Period Resources

No pre-contact period Native American resources were identified within the preliminary project APE. The subsurface testing results conducted during the survey combined with unfavorable environmental factors and the extent of post-contact period industrial soil disturbances indicates an overall low potential for important Native American archaeological resources to be present. Test pits were placed within the project APE in areas indicated as moderately sensitive by VDHP's environmental predictive model for pre-contact habitation settlement sites and in areas identified as having moderate Native American sensitivity based on the walkover survey. Archaeological testing in these areas recovered no pre-contact period cultural materials. No additional archaeological investigations for Native American sites within the project APE are recommended.

It is possible that additional areas of potential effect including borrow pits and access roads may be identified in archaeologically sensitive areas outside of the current APE, in which case archaeological survey may be warranted. The survey work would be designed to identify and evaluate any potentially important belowground pre-contact period Native American resources.

Post-Contact Period Resources

Landscape Features

Typical site environmental characterization work such as monitoring well access, machine trenching, and laydown activities would be likely to cause irrevocable changes to the landscape and important cultural features related to industrial and domestic subsites. Because of this an aerial and terrestrial color digital photographic documentation of the mine landscape was undertaken concurrently with the completion of the historic and archaeological mapping and testing fieldwork.

In addition, although some of the identified landscape features may not have high archaeological interpretive potential because of integrity, they still have the potential to interpret ore processing and waste deposition on a large scale as surviving landscape features, and are therefore worthy of avoidance and preservation.

Archaeological Resources/Sensitive Areas

A number of the identified industrial period resources including the ore processing mill and blacksmith shop area have been assessed as having the potential to contain archaeological deposits that would contribute important new information to the historical record (see Table 9-1). The current survey also identified domestic archaeological resource areas within the project APE that have the potential to address important priority research topics in the state of Vermont (see Table 9-2).

Typical site environmental characterization work such as site access development and equipment laydown, monitoring well drilling, and machine trenching would be likely to cause irrevocable changes to the landscape and important cultural features related to industrial and domestic subsites. Any ground disturbing activities associated with site environmental characterization work should take place with consideration for further investigating the domestic and industrial archaeological resource areas as shown on Figure 9-1 and in Appendix B except for the identified Prospect Trenches and Isolate Subsites assigned low archaeological potential and research value. A collaborative effort between cultural resource specialists and a project geotechnical team would be expected to provide some of the information identified as data gaps in the research priority topics discussed above. Pending the evaluation of archaeological data collected during potential site characterization work, additional systematic archaeological investigations of targeted resources could be warranted as part of mitigation efforts for a cleanup project. Domestic and industrial archaeological resource areas having high research potential should be avoided during site environmental characterization work and cleanup activities.

It is possible that additional areas of potential effect including cleanup activity borrow pits and access roads could be identified in archaeologically sensitive areas outside of the preliminary APE, in which case archaeological survey might be warranted. The survey work would be designed to identify and evaluate any potentially important belowground post-contact period resources.

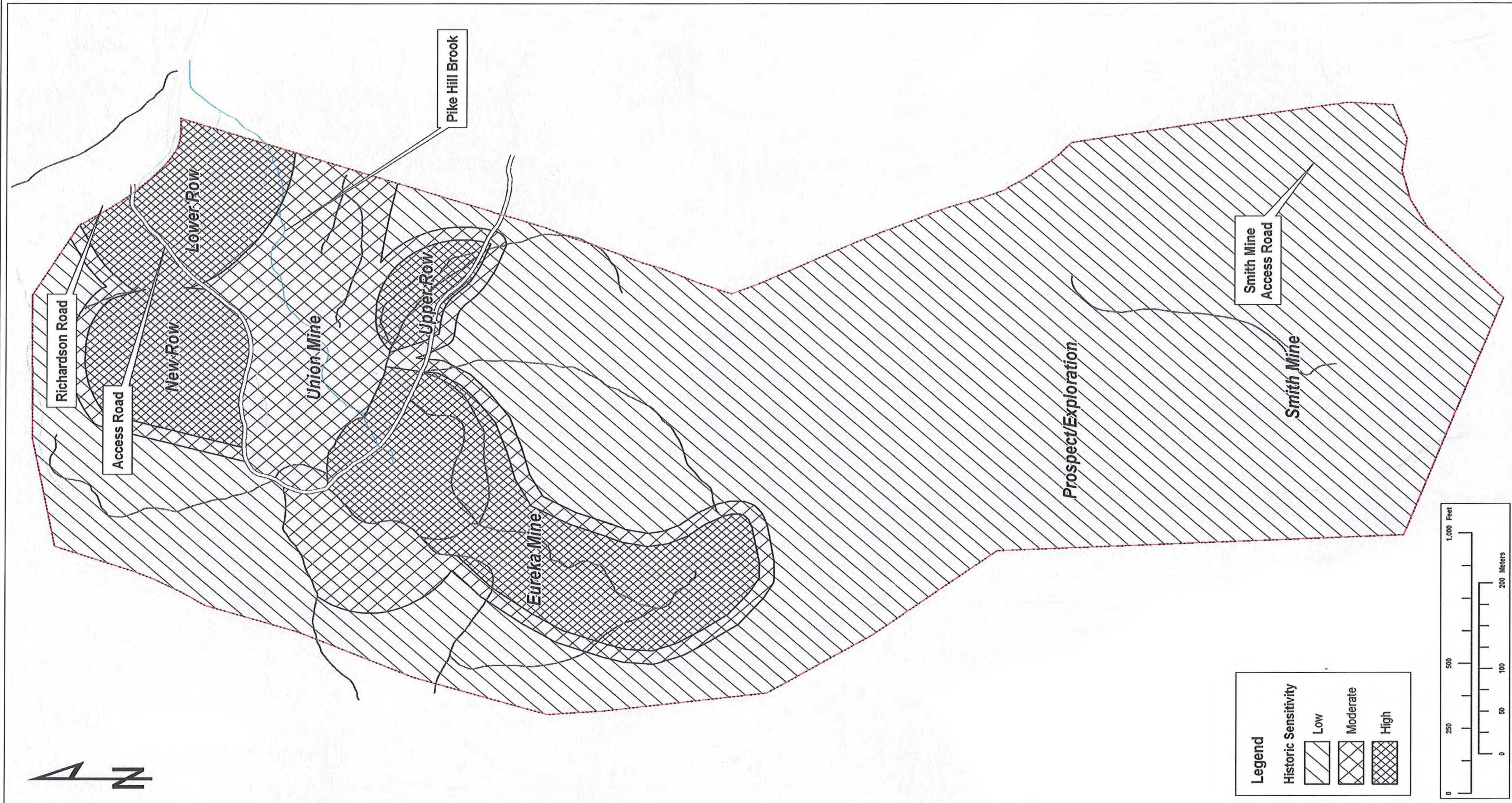

Figure 9-1. Historic period archaeological resources sensitivity assessment, Pike Hill Mines Site Preliminary Project APE.

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